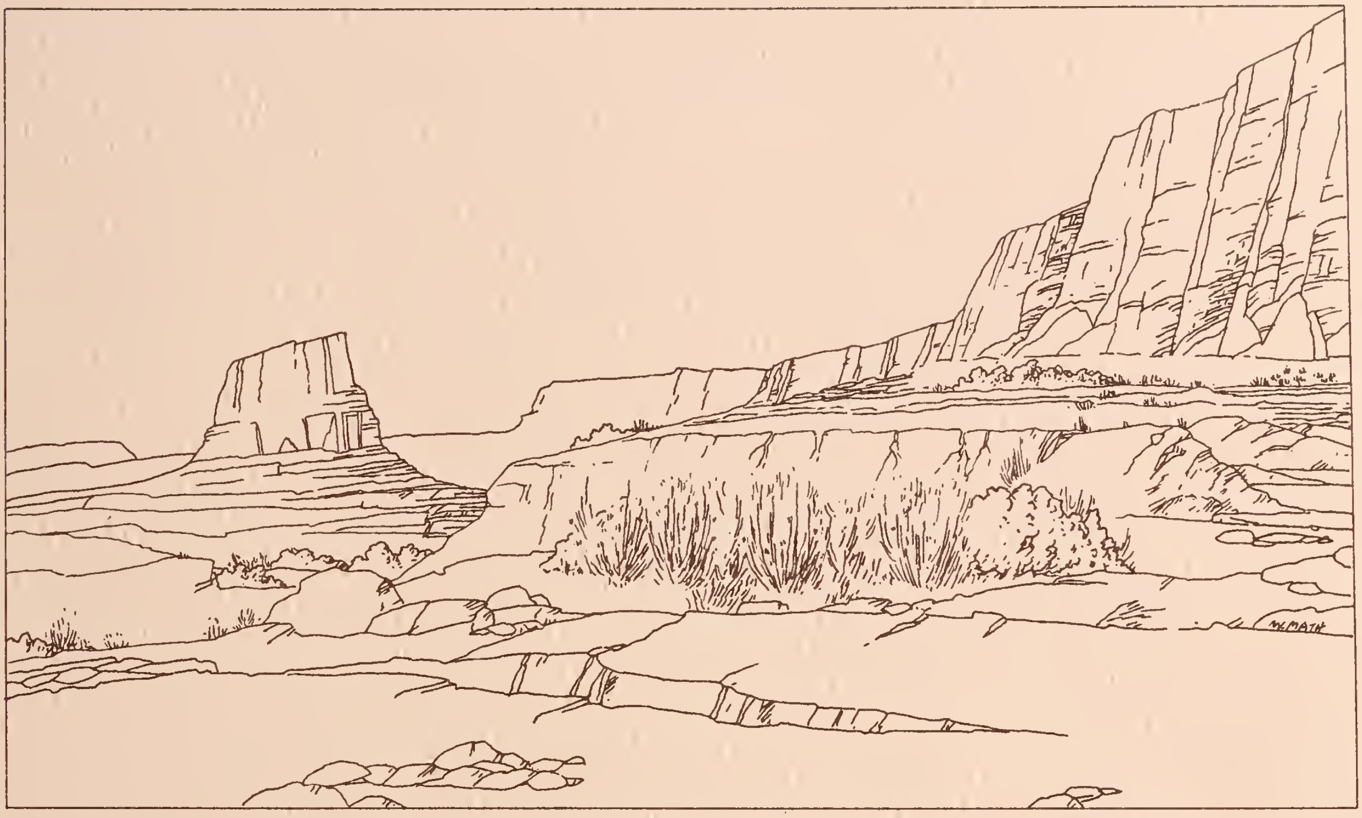

KAIPAROWITS COAL DEVELOPMENT AND TRANSPORTATION STUDY

FINAL REPORT — AUGUST 1, 1980

ERT
ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.
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PREFACE

On August 29, 1979, the Bureau of Land Management (BLM) awarded a contract to Environmental Research & Technology (ERT) to conduct the Kaiparowits Coal Development and Transportation Study. ERT utilized the following subcontractors in completion of the study:

Hydro-Data, Inc.—Surface and Groundwater Hydrology
Sergent, Hauskins & Beckwith—Geology, Topography and Minerals
Museum of Northern Arizona—Archaeology and Paleontology
Richard Stoffle (University of Wisconsin-Parkside)—Ethnology
Stan Albrecht (Brigham Young University)—Socio-Cultural
Gary Dudley (Applied Conservation Technology)—Technical Consultant
E. Arlo Richardson (Utah State Climatologist)—Existing Climate

Mr. Mike College of the BLM Denver Service Center was the contracting officer and Mr. John Stephenson of the BLM Utah State Office was the Contracting Officers Authorized Representative (COAR). A Federal, state, and local agency Steering Committee was established to insure agency coordination and input to the Kaiparowits Study. The Steering Committee also provided support to the BLM in a guidance and review capacity throughout the Kaiparowits study. The Steering Committee members along with the agencies they represented are presented as below:

Name	Agency
• Gerry Magnuson, Chairman	BLM, Utah State Office
• Morgan Jensen	BLM, Cedar City District
• Jeff Sirmon	U.S. Forest Service
• Phil Wondra	National Park Service
• Milo Barney	Utah Department of Natural Resources
• Jim Butler	Utah State Planning Coordinator's Office
• John Williams	Five-County Association of Governments

The funding and support for this project came from several sources. The BLM provided the basic financial support for the study and the National Park Service contributed additional funding for the air quality studies. The State of Utah provided financial support for socio-economic studies and contracted directly with the Five-County Association of Governments to complete the socio-economic studies.

It should be noted that the study report generally follows the format requirements for an environmental impact statement (EIS) but *it is not* an EIS. The study does not evaluate specific proposed actions, but rather summarizes the potential environmental impacts of various levels of coal development and various modes of coal transportation from the Kaiparowits region.

While ERT has been provided guidance by the Steering Committee, the findings, opinions, or conclusions expressed in this report are those of the authors and do not necessarily reflect the views of specific Federal, state, and local agencies.

SUMMARY

The Kaiparowits Coal Development and Transportation study resulted from an agreement made by the Secretary of the Interior and Governor Scott Matheson of Utah for a cooperative study by the Department and the State of Utah to review the issues raised by potential mining and transportation of coal from the Kaiparowits Plateau. The study concentrated on the following questions:

1. Would the physical impacts from mining Kaiparowits coal cause unacceptable damage to National Park, National Forest, or Bureau of Land Management (BLM) lands?

2. Would the physical impacts of coal transport by rail or coal slurry pipeline within corridors to be identified by the study be inconsistent with preservation of National Park or other Federal land values?

3. How might the population increases that could result from mining affect the use of National Parks and other Federal lands, and what land management steps should be considered to protect the National Parks and other areas from damage that might be caused by increased population?

4. How should Federal resource management decisions—Wilderness, Areas of Critical Environmental Concern, Class I air quality designation, identification of potential transportation corridors or community sites—be coordinated?

Information developed in response to such questions will provide a foundation to help the state and Federal land managers address important policy questions. The study will help the Department, state and local agencies, and the general public understand basic issues such as whether designation of rail or slurry transportation corridors would conflict with National Park or other Federal land management policies. The study will stimulate participating agencies to perform their own analyses of these questions. The study does not look at issues related to mine-mouth use of Kaiparowits coal or economic feasibility of Kaiparowits coal development. Any such end-use questions would be addressed in site-specific environmental impact statements resulting from mine development or transportation rights-of-way applications to BLM, the Office of Surface Mining (OSM), and other agencies.

The study also provides new environmental analyses specifically directed at coal transportation via various transportation modes and corridor alternatives. It combines information and analysis in one report, including narrative presentation, graphics, and appendices, in such a manner as to be technically correct and yet readily understood by a non-technical reader. Where appropriate, environmental and technical data gaps and opportunities for interagency coordination are identified.

Since the Kaiparowits Coal Development and Transportation Study is a regional planning study, this report does not present a detailed discussion of certain potential impacts that could result from specific projects. However, a detailed analysis would be conducted as part of any site-specific environmental impact statement prepared for a mining plan and/or right-of-way application. The primary intent of the report is to inform the public and decision makers of the most significant impacts, issues, and trade-offs involved with various levels of coal production and transportation in the Kaiparowits region of southern Utah. This information can then be used by Federal, state, and local governments, industry, interest groups, and the general public to determine whether or not various mining locations, coal production levels, and transportation modes are acceptable within the region. This report is intended to present objectively potential impacts and avoids making value judgements about the desirability of coal development or the acceptability of impacts.

STUDY SCENARIOS AND TRANSPORTATION CORRIDORS

Unlike an environmental impact statement which has a set of distinct alternatives for evaluation, the Kaiparowits Coal Development and Transportation Study does not have a specific development proposal or "proposed action" on which to base impact analysis. Therefore, it was necessary to develop study scenarios which included different levels of coal development, mining methods, and transportation modes. In addition, it was important to select transportation planning corridors within the study area.

Three study scenarios which would define the potential type of development in the study area were identified (Table 1). These scenarios

TABLE 1
STUDY SCENARIOS

Lease Area	Coal Production (10^6 T/yr.)	Mining Method	Transportation Mode
Low Level			
Alton	2	surface	truck
North Kaiparowits	1	underground	truck
South Kaiparowits	2	underground	truck
TOTAL	5		
Medium Level			
Alton	9[a]	surface & underground	slurry pipeline
North Kaiparowits	15[b]	surface & underground	slurry pipeline
South Kaiparowits	30	underground	rail
TOTAL	54		
High Level			
Alton	9[a]	surface & underground	slurry pipeline
North Kaiparowits	30[c]	surface & underground	rail
South Kaiparowits	45	underground	rail
TOTAL	84		

Source: ERT Project Team Years

[a]Years 1-20 all surface mining
Year 21, 75% surface, 25% underground
Year 22, 50% surface, 50% underground
Year 23, 25% surface, 75% underground
Years 24-40, all underground mining

[b]2 million tons/year surface mining
[c]3 million tons/year surface mining

deal primarily with coal production levels, mining methods, coal transportation modes, and development levels. The coal production levels chosen for evaluation in the scenarios were based on two major considerations: (1) the capacity of the specific coal transportation modes and (2) the diligent development requirements contained in the Code of Federal Regulations (43CFR 3500.0-5 f). In addition, many Federal, state, and industry representatives were contacted before the eight coal production levels were recommended to the Kaiparowits Steering Committee. The coal transportation corridors and truck haul routes developed for the study are shown on Map 2-1. The corridors and haul routes were further divided into 18 transportation corridor segments and 16 truck haul route segments. Coal transportation directions are outlined in Table 2.

The coal transportation corridors were identified by a constraint mapping process. A series of constraint maps for each discipline was developed. A composite constraint map was subsequently prepared and corridor segments avoiding the constraints were delineated.

GENERAL ENVIRONMENTAL SETTING

The geological history of southern Utah plays a strong role in shaping the environment evident today. The land is dominated by severe topography in the forms of deeply cut river canyons, long escarpments, high mesas, and sharply rising mountain ranges. The climate is characterized by hot summers, mild winters, and low amounts of precipitation at the lower elevations and cool summers and cold, snowy winters at the higher elevations. Air quality and visibility are characteristically excellent. Much of the region's precipitation falls in the form of summer thundershowers. These precipitation patterns have limited soil development, especially on steep slopes. The best developed soil in the region occurs in the alluvial valleys. Surface water is scarce and

TABLE 2
COAL TRANSPORTATION AND DESTINATION

Geographical Coal Lease Areas	Possible Corridor Directions Railroads and Coal Slurry Pipelines
Alton	northwest, west, south
North Kaiparowits	north, south, west, northwest
South Kaiparowits	north, south, west, northwest
Possible Corridor Direction	*Railroad Destination*
North (C9)	Denver & Rio Grande Western RR spurline at Salina, Utah
Northwest (C4)	Union Pacific RR mainline at Milford, Utah
West (C1)	Union Pacific RR spurline at Cedar City, Utah
South (C18)	Santa Fe RR mainline at Flagstaff, Arizona

Source: ERT Project Team

much existing water has been appropriated for human use. Groundwater supplies are thought to be good, especially in the Navajo sandstone which is a very deep aquifer; however, Navajo sandstone recharge rates are unknown at the present time.

Vegetation communities range from desert shrub associations of shadscale, rabbitbrush, sagebrush, and creosote bush, to pinyon-juniper woodlands, and at higher elevations to ponderosa pine and aspen forests. A number of plants with limited habitats have evolved in the region. Many of these are currently being reviewed for protection under the Endangered Species Act. One cactus species *(Pediocactus sileri)* is listed as endangered. Many wildlife species inhabit the wide variety of vegetation communities. Common big game animals include mule deer, elk, antelope, and mountain lion. Endangered species include the bald eagle, peregrine falcon, and Utah prairie dog. The region's fisheries are limited by the scarcity of surface water. Higher mountain streams support small populations of trout and slower, warmer rivers contain species such as suckers or shiners. The only fish classified as endangered is the woundfin minnow found in the Virgin River.

The area is sparcely settled and inhabited areas, including the small population centers, are rural in character. The economic base is centered around ranching and other agricultural pursuits. A significant portion of local income (over 58 percent in Kane County and 34 percent in Garfield County) is derived from the tourist industry, particularly in the larger towns of the region. There is also a limited amount of mining and timber harvest activity. Much of the population is of the Mormon faith and lifestyle is predominantly conservative in nature with a strong religious influence. Land use reflects the socioeconomic conditions with a large majority of the land used for grazing; cropland is also an important though proportionally much smaller land use. Much of the public lands and National Forests are used for recreation. Sizeable parcels have been designated as National Parks, National Recreation Areas, and state parks and set aside permanently for public enjoyment. The parks, National Monuments, and other recreation areas encompass blocks of land with outstanding geologic and scenic qualities, although many features outside these areas are also high in scenic quality. Significant portions of the region are currently being evaluated for wilderness potential. The region offers a great deal of recreation opportunity and records a high number of visitor-use days, especially in the National Parks.

Native American habitation in the region has occurred since prehistoric time and resources considered sacred by these groups are plentiful and occur throughout the area. Such resources include artifacts, animals, burials, petroglyphs and pictographs, places, plants, and trails. The transportation system consists primarily of local roads connecting the small and scattered population centers and major highways traversing the region. Much of the area is accessible only on unimproved roads. Noise levels are generally low with noise production occurring primarily along the more travelled roadways.

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ENVIRONMENTAL CONSEQUENCES

Impact analysis for this study concentrated on the expected impacts resulting from three potential levels of coal production on the three lease areas and from three different modes of coal transportation off these lease areas to existing transportation systems and/or market areas. Only those resource elements which would be significantly affected by coal development and transportation were discussed. In most cases, physical impacts were limited to lease areas, transportation corridors, and truck haul routes. However, certain elements such as air quality and visibility, visual resources, transportation, socioeconomics, and recreation required analysis over a broader area due to the regional nature of potential impacts.

Since this was a regional planning study lacking a well-defined proposed action, it was necessary to develop assumptions on which to base impact analysis. Even with these assumptions, it was sometimes not possible to quantify potential impacts or describe their significance. This would be accomplished when site-specific proposals are analyzed. It should be noted that air quality and groundwater modeling based on specific mining and reclamation plans could generate results which would be different from those presented in this report. Detailed discussion of the environmental impacts can be found in Chapter 4 (Environment Consequences). However, a summary of the environmental impacts of the scenarios is presented in Table 3. Where data were not available in the Environmental Consequences chapter to quantify impacts, a qualitative description of the impact has been included.

SIGNIFICANT ENVIRONMENTAL ISSUES

Introduction

Development of coal resources in the Kaiparowits study area could result in significant environmental impacts. The significance of these impacts would be dependent upon several factors including the level of coal production, location of coal development, and type and location of coal transportation facilities. However, based on the conclusions of this study in which a series of scenarios were analyzed, it is apparent that there are six major environmental elements which could be significantly impacted. These impacts would have to be considered and evaluated by appropriate Federal and state agencies before site-specific coal development decisions in the study area are made. The six major environmental elements are as follows:

- Air Quality
- Visibility
- Water Resources
- Wilderness Resources
- Transportation
- Socioeconomics

A detailed discussion of the impacts to other environmental elements which were judged to be less significant in a regional planning sense can be found in Chapter 4 and summarized in Table 3. A summary discussion of the six most significant issues follows:

Air Quality

Modeling results indicate that unmitigated emissions from the development and transport of coal resources at each of the three production levels would result in violations of National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments for total suspended particulates (TSP). Mitigation measures must achieve high levels (88-96 percent) of emission reductions so that PSD increments and NAAQS would not be violated. The effectiveness of individual mitigation measures in reducing TSP emissions varies. Mitigation techniques for fugitive dust sources range from preventive measures which limit the disturbance of dust-producing soils to modifications of the emitting surface by watering or paving. Appendix J of this report contains a listing of different mitigation measures and their estimated control efficiency.

Dust emissions (TSP) from direct mining and transportation sources must be reduced by 88 percent in the low (5 MTY) scenario, 94 percent in the medium (54 MTY) scenario, and 96 percent in the high (84 MTY) scenario in order to meet the PSD increment and NAAQS. Implementation of mitigation measures adequate to achieve these levels of emission reductions would require advance planning and use of best available control technology (BACT). If reduction of direct mining emissions to the requisite levels proves infeasible, control of secondary sources (through such things as zoning laws, land use planning, traffic control, etc.) may be necessary. Air quality control strategies would require enforcement measures and cooperation among Federal, state, and local agencies and industry.

TABLE 3
SUMMARY COMPARISON OF IMPACTS FOR STUDY SCENARIOS

Low Production Level (5 MTY) Truck Haulage *"See Brown Section"*	Medium Production Level (54 MTY) Slurry Pipelines & Railroad *"See Beige Section"*	High Production Level (84 MTY) Slurry Pipeline & Railroads *"See Green Section"*	Significant Data gaps
	Air Quality		
In stagnant, worst case situations unmitigated Alton TSP emissions are projected to exceed PSD Class I and II annual increments by 2 to 5 times. Mitigation of 88% would reduce TSP values and avoid violating any Federal or State air quality standards. Truck transport coal blow-off is expected to approach 90% of PSD limiting values at Bryce Canyon (Utah 12) and east of Kanab (U.S. 89) when unmitigated. No impact from non-TSP pollutants project.	Unmitigated TSP mine emissions in all lease areas would exceed Class I increments locally by as much as 20 times and NAAQS by 2 to 3 times. Unmitigated rail coal blow-off would exceed Class II increment at levels exceeding 10 MTY coal hauled. Regional 24-hr TSP concentrations exceeding 100 mg/m3 would occur up to 10 mi NE of all lease areas. Mitigation of 88% would be sufficient to meet air quality standards at North Kaiparowits, but additional mitigation would be required for South Kaiparowits (91%) and Alton (94%) to reduce emissions to a level that would not violate Class I or II increments. No impact from non-TSP pollutants is projected.	Unmitigated TSP mine emissions in all lease areas would exceed Class I increments locally by as much as 20 times and NAAQS by 2 to 5 times. Mitigation of 88% would be sufficient to meet air quality standards at North Kaiparowits, but additional mitigation would be required for South Kaiparowits (96%) and Alton (94%) to reduce emissions to a level that would n violate Class I or II increments.	None
	Visibility		
No projected visual range reduction for either mitigated or unmitgated cases for any year.	Increase in TSP concentrations under unmitigated conditions would reduce the visual range for the Bryce Point to Navajo Mountain Vista from 200 to 109 km (124 to 68 mi). With 88% mitigation, visual range would be reduced to 177 km (110 mi) which represents a 12% reduction. Navajo Mountain would be visible 50% of the time as compared to 75–85% of the time at present. No effect on other vistas in the study area.	Increase in TSP concentrations under unmitigated conditions would reduce the visual range for the Bryce Point to Navajo Mountain Vista from 200 to 49 km (124 to 30 mi). With 88% mitigation, visual range would be reduced to 177 km (110 mi) as was described for the medium scenario. No effect on other vistas in the study area.	Baseline visibility data needs to be expanded. The overall impact of decreased visibility on visitation at the National Parks needs to be investigated.

TABLE 3
SUMMARY COMPARISON OF IMPACTS FOR STUDY SCENARIOS—Continued

Low Production Level (5 MTY) Truck Haulage *"See Brown Section"*	Medium Production Level (54 MTY) Slurry Pipelines & Railroad *"See Beige Section"*	High Production Level (84 MTY) Slurry Pipeline & Railroads *"See Green Section"*	Significant Data gaps
	Geology/Topography/Minerals		
Mining would result in the nonrecovery of 3 MTY in the underground mines and 0.13 MTY in the surface mines. Topography would be modified due to surface mining in the Alton area resulting in high walls as high as 150 feet and creation of spoil piles up to 225 feet high. An unquantifiable amount of subsidence would occur over the underground mined area. Underground mines would require 0.016 MTY of limestone for dusting shaft walls.	Impacts on topography and subsidence would be similar to the low production scenario except greater volume of coal mined would result in propor tionately greater impacts. Volume of nonrecoverable coal would range from 43 to 52 MTY in underground mines and about 0.7 to 0.13 MTY in surface mines. Volume of limestone required would range from 0.25 to .29 MTY. Ballast requirements for rail road bed would be approximately 9,000 tons/mile.	Impacts on topography and subsidence would be similar to but larger than those identified for the medium production. Volume of nonrecoverable coal would range from 72 to 81 MTY in underground mines and about 0.19 to 0.77 MTY in surface mines. Volume of limestone required would range from 0.40 to .45 MTY. Ballast requirements would be te same as medium scenario.	The effects of blasting in the Alton lease area on geologic formations in Bryce Canyon National Park need to be assessed.
	Soils		
Approximately 4,992 acres of soil would be disturbed by mining and 1,111 acres disturbed by expansion of existing communities.	Approximately 19,338 acres would be disturbed by mining and 7,195 acres disturbed by urban development.	Approximately 23,563 acres would be disturbed by mining and 9,678 acres disturbed by urban development.	
	Water Resources		
Impacts on groundwater quality and quantity would not be significantly affected. Sediment movement from spoil piles would not adversely affect water quality in the streams. Overall water requirements would be minimal with no significant impacts on the regional water availability.	Construction of railroads and slurry pipelines would result in temporary increases in runoff and sediment. A potential pipeline rupture could adversely affect water quality in streams receiving discharge. Operation of coal slurry pipeline would affect the groundwater stored in the Navajo Sandstone. In the Alton lease area, water level drawdown in the	Impacts would be similar to those identified for the medium scenario except water requirements would decrease for the North Kaiparowits lease area. This would result in a smaller decrease in the Navajo Sandstone water level for that area. The one-foot drawdown point of the cone of depression would extend 10.9 miles from the center of either well field.	Additional field testing should be conducted to determine more accurately the storage coefficients and recharge rates for the Navajo Sandstone aquifer.

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SUMMARY COMPARISON OF IMPACTS FOR STUDY SCENARIOS—Continued

Low Production Level (5 MTY) Truck Haulage *"See Brown Section"*	Medium Production Level (54 MTY) Slurry Pipelines & Railroad *"See Beige Section"*	High Production Level (84 MTY) Slurry Pipeline & Railroads *"See Green Section"*	Significant Data gaps
Water Resources			
	immediate vicinity of the well field would reach 350 feet after 40 years of pumping. Regional effect would be a 1-foot drawdown extending to a 11.8-mile radius from either of the well fields analyzed.		
	This drawdown would eventually reduce flow by 25% to 50% in the East Fork of the Virgin River and reduce output or interrupt flows in Johnson Canyon Springs. In the North Kaiparowits area, drawdown would reach 450 feet after 40 years of pumping. The 1-foot cone of depression would extend an estimated radius of 12.7 miles.		
	Overall drawdown in Navajo Sandstone would not affect shallower aquifers and would not affect existing wells.		
Vegetation			
Approximately 4,992 acres of vegetation would be removed from production at the mine areas over the project period. An additional 1,111 acres would be lost due to expansion of existing communities.	Approximately 19,338 acres of vegetation would be removed from production at the mine areas over the project period. An additional 7,195 acres would be lost to urban development.	Approximately 23,563 acres of vegetation would be removed from production at the mine areas over the project period. An additional 9,678 acres would be lost to urban development.	More detailed information on the locations of endangered species is needed.
Approximately 2,353 AUMs would be lost over the project period. This would represent less than 1% loss of Federal AUMs in the three planning units affected.	Approximately 9,217 AUMs would be lost over the project period. This would represent about a 1% loss of the Federal AUMs in the three planning units affected. Although potential impacts to threatened or endangered plant species is not directly related to area disturbance, there would be an increase in potential impacts over the low scenario.	Approximately 11,323 AUMs would be lost over the project period. This would represent a nearly 2% loss of the Federal AUMs in the planning units affected.	
Threatened or endangered plant species could be potentially affected.		Potential impact to threatened or endangered plant species would be slightly higher than for the low medium scenarios.	

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	Wildlife		
Approximately 4,992 acres of wildlife habitat would be lost for the life of the projects (40 years). An additional 1,111 acres would be lost permanently due to urban development. Increased traffic (coal trucks and personal vehicles) would result in loss of 105 deer/year (62% increase over current loss rates). Mining could indirectly impact aquatic ecosystem due to introduction of sediments or toxic materials. Increased population in southern Utah would result in increased legel and illegal game harvest and increased access to remote areas would lead to increased wildlife disturbance.	Approximately 19,338 acres of wildlife habitat would be lost for the life of the projects (40 years). An additional 7,195 acres would be lost permanently due to urban development. Increased traffic would result in loss of 165 deer/year (97% increase over current conditions). Operations of coal slurry pipelines would result in flow reductions in the East Fork of the Virgin River in the vicinity of Alton. The flow reductions would result in moderate to severe impacts to all aquatic species near Alton. Impacts associated with human activity would be similar to the low scenario, only greater in magnitude.	Approximately 23,563 acres of wildlife habitat would be lost for the life of the projects (40 years). An additional 9,678 acres would be lost permanently due to urban development. Increased traffic would result in loss of 316 deer/year (186% over current conditions). Impacts on the East Fork of the Virgin River would be the same as described for medium scenario. Impacts associated with human activity would be similar to the low scenario, only greater in magnitude.	More detailed information on the location and habitat requirements of endangered species is needed.
	Paleontology		
Direct impacts to significant fossils may result from disturbances of overburden by mining activities. Indirect impacts would result from increased population growth and subsequent collection of resources by rock hounds.	Impacts would be similar to the low scenario but greater in magnitude because of the larger area disturbed by mining activities.	Impacts would be similar to those described for the low scenario but would be greater in magnitude because of the larger area disturbed by mining activities.	Site-specific proposals would require detailed surveys to locate paleontological resources.

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Low Production Level (5 MTY) Truck Haulage *"See Brown Section"*	Medium Production Level (54 MTY) Slurry Pipelines & Railroad *"See Beige Section"*	High Production Level (84 MTY) Slurry Pipeline & Railroads *"See Green Section"*	Significant Data gaps
	Archaeological Resources		
Projections indicate 116 archaeological sites would be disturbed by development of coal resources. Appropriate mitigation measures (e.g., avoidance of known sites) would significantly reduce the number of sites disturbed.	Approximately 434 to 457 archaeological sites would be disturbed by coal development, construction of railroad line or slurry pipeline and development of the new community near East Clark Bench. Construction of coal slurry pipeline or railroad could potentially impact sites either on or nominated to the National Register of Historic Places. Appropriate mitigation measures or careful siting of the rights-of-way would significantly reduce the number of sites disturbed.	Approximately 556 to 579 archaeological sites would be disturbed by coal development, construction of railroad line or slurry pipeline and development of the new community near East Clark Bench. Potential impacts to National Register of Historic Places sites would be the same as described for the medium scenario. Appropriate mitigation measures or careful siting of the rights-of-way would significantly reduce the number of sites disturbed.	Site-specific -proposals would require detailed surveys to locate archaeological sites.
	Native American		
Development of coal resources could adversely affect the following native American sacred resources: 1) burial sites 2) sacred plant resources such as native American basket plants 3) sacred places and trails The number of resources impacted and significance of impact would be dependent upon location of mining and related activities.	Impacts would be similar to those described for the low scenario but would be greater because of the larger area disturbed by mining activities. Additional impacts would be associated with construction of railroads or slurry pipelines in the corridors.	Impacts would be similar to those described for the medium scenario but would be greater because of the larger area disturbed.	Native American groups should be contacted to review site-specific proposals for identification of concerns.
	Visual Resources		
Surface mining at the Alton lease area would exceed the BLM visual class standards for Class II areas. The Class II area of the Alton field is extremely sensitive because it is in the foreground for Yovimpa Point.	Impacts to the Alton lease area would be similar to the low scanario. Surface mining in the northerly sections of the North Kaiparowits field would not meet visual resource standards.	Impacts would be similar to impacts for the medium scenario but would be greater in magnitude.	None

TABLE 3
SUMMARY COMPARISON OF IMPACTS FOR STUDY SCENARIOS—Continued

Low Production Level (5 MTY) Truck Haulage *"See Brown Section"*	Medium Production Level (54 MTY) Slurry Pipelines & Railroad *"See Beige Section"*	High Production Level (84 MTY) Slurry Pipeline & Railroads *"See Green Section"*	Significant Data gaps
Recreation			
Recreation traffic would conflict with mine employee traffic. Increased recreation demand from coal-related population growth would result in excessive use pressure on developed facilities such as campgrounds which are currently used at or over capacity. Many forms of recreation would suffer decreased quality of the recreation experience and there would be more conflicts between incompatible uses such as hiking and motorcycling due to increased population. Mining activities in the Alton lease area would degrade visual quality from Yovimpa Point whidh could reduce visitor satisfaction and, possibly, decrease tourism somewhat.	Recreation traffic conflicts with coal production employee traffic would be much more severe than at the low scenario. Other impacts would be similar to those described under the low scenario but the degree of impact would be significantly greater due to greatly increased local population. Long distance views from scenic overloads would be reduced slightly whieh would have a slight effect on visitor satisfaction.	Recreation traffic conflicts with coal production employee traffic would be substantially more severe than the medium scenario. Other impacts would be similar to those described under the medium scenario. Visual effects would be approximately the same. Other effects would be substantially more severe due to greatly increased poulation	Effects of mining and visual quality changes on tourism and visitor satisfaction are not well understood and should be investigated further.
Wilderness			
Proposed wilderness study area at the northeast corner of the South Kaiparowits field would, if approved, preclude development of surface facilities on about 10% of that field.	In addition to the South Kaiparowits lease area conflict described under the low scenario, portions of corridor segments C1, C6, C7, C10, C13, C14 and C15 are under study for wilderness designation. These areas would be unavailable for use as rights-of-way unless and until they were released from wilderness consideration.	Same as medium scenario.	Wilderness study areas will not be officially designated in southern Utah until November 1980. Actual wilderness designation may not take place until the 1990s. Exact effects on corridor segments can not be determined at this time.

TABLE 3
SUMMARY COMPARISON OF IMPACTS FOR STUDY SCENARIOS—Continued

Low Production Level (5 MTY) Truck Haulage *"See Brown Section"*	Medium Production Level (54 MTY) Slurry Pipelines & Railroad *"See Beige Section"*	High Production Level (84 MTY) Slurry Pipeline & Railroads *"See Green Section"*	Significant Data gaps
	Land Use		
Development would result in conversion of approximately 4,992 acres of cropland, grazing land, and forest land to mining and mining related activities. Loss of cropland in the Alton lease area would be a significant adverse impact. Loss of grazing land would not be a significant regional impact. Urban expansion would require approximately 1,111 acres.	Development would result in conversion of approximately 19,338 acres of cropland, grazing land, and forest land to mining and mining related activities. Loss of cropland in the Alton lease area (approximately 4 x greater than low scenario) would be a significant adverse impact. Loss of grazing land would not be a significant regional impact. Population increase associated with this level of development would create demand to convert land (approximately 7,195 acres) to urbanized uses. Expansion of communities would create additional land use conflicts.	Development would result in conversion of approximately 23,563 acres of cropland, grassland, and forest land to mining and mining related activities. Significance of loss of cropland in the Alton lease area and grazing land would be the same as identified for the medium scenario. Population increases would be greater and demand for additional land converted to urbanized use (approximately 9,678 acres) would be greater.	None
	Transportation		
Coal development would generate increased levels of traffic in the study area. Projected peak hour demand would exceed Utah Department of Transportation Standards for Level of Service B for U.S. 89 between U-9 and U-14. Approximately 125 to 150 more accidents per year could occur due to additional coal-related traffic.	Increased traffic from the North Kaiparowits lease area would exceed standards on U-12 between Tropic and Escalante and could impede recreational traffic on U-12 between Escalante and Bryce Canyon. Combined impact of recreation travel and coal development traffic would exceed standards on U.S. 89 east of Kanab and result in reduced operating speeds with periods of back-ups during the a.m. and p.m. peak hours. Approximately 200 to 225 more accidents per year could result. Unit coal train operations would result in traffic flow delays and create a potential for vehicle-train accidents.	Increased traffic from North Kaiparowits would exceed the Level of Service B volume standard on U-12 and exceed the theoretical capacity for two-lane highways in the vicinity of Escalante. Projected traffic would exceed Level of Service B volume of standard for following road segments a) U.S. 89 between U-9 and U-14 b) U.S. 89 between Kanab and Page. Cumulative impacts of Alton and South Kaiparowits mine employee traffic would occur on U.S. 89 west of Kanab. Approximately 350 to 370 additional accidents per year could result. Unit coal train operations would result in traffic flow delays and create a potential for vehicle-train accidents.	None

TABLE 3
SUMMARY COMPARISON OF IMPACTS FOR STUDY SCENARIOS—Continued

Low Production Level (5 MTY) Truck Haulage *"See Brown Section"*	Medium Production Level (54 MTY) Slurry Pipelines & Railroad *"See Beige Section"*	High Production Level (84 MTY) Slurry Pipeline & Railroads *"See Green Section"*	Significant Data gaps
		Socioeconomics	
Significant positive socioeconomic effects under this scenario would be as follows: Approximately 1,990 new permanent jobs would be directly created in mining and coal transportation; An estimated $35 million annually in direct salaries and wages would be added to the area economy; Kane and Garfield Counties would experience operating revenue surpluses Significant negative socioeconomic effects would be as follows: Current residents on fixed incomes would be adversely affected by above average price increases for goods and services; highway maintenance requirements would increase substantially; county level capital improvements needs would be accelerated; All communities affected by coal related growth would experience significant revenue shortfalls at current tax rates, some would require doubling projected revenues to maintain service levels; many communities would face significant capital improvements needs, in particular, water system, waste water treatment and school needs would have to be in place prior to population growth which would pose significant "front-end" financing problems. Significant socioeconomic effects with both positive and negative connotations would be substantial, rapid population growth of communities and an alteration of the employment structure of the area economy.	Significant positive socioeconomic effects under the medium scenario would be as follows: approximately 13,130 new permanent jobs would be directly created in mining and coal development; an estimated $251 million annually in direct salaries and wages would be added to the area economy; county level operating revenue surpluses would be substantially higher than under the low scenario for Kane and Garfield Counties. Significant negative socioeconomic effects would be as follows: adverse effects on fixed income residents would be substantially more severe than under the low scenario because of much higher price pressures; county level capital improvement needs would be substantially greater than under the low scenario; community level operating revenue shortfalls would be substantially more severe under the medium scenario since service demands tend to increase faster than population growth while revenues do not keep pace with population growth; front-end financing problems for community capital improvement needs would be substantially more serious and would affect nearly all communities; areas affected by transportation facilities construction in Beaver and Washington Counties would experience short-term,"boom bust" conditions due to construction activities. Significant socioeconomic effects with both negative and positive aspects would be: very substantial, very rapid population growth in study area communities; a substantial alteration of	Significant positive socioeconomic effects under this scenario would be as follows: Approximately 21,600 new permanent jobs would be directly created in mining and coal transportation; an estimated $413 million annually in direct salaries and wages would be added to the area economy; operating revenue surpluses for Kane and Garfield Counties would be substantially greater than at the medium scenario level. Significant negative socioeconomic effects would be: adverse effects on fixed income residents would be much more severe; county level capital improvement needs would be substantially greater; all study area communities would experience substantially greater operating revenue shortfalls; front-end financing problems and capital improvement needs at the community level would be substantially more severe and would affect essentially all communities; Beaver and Washington County effects would be essentially the same as under the medium scenario. Significant socioeconomic effects with positive and negative aspects would be: population increases in all communities, ranging as high as 26 times greater than baseline population projections; the employment structure of the area economy would be significantly altered with mining becoming the dominant sector.	A housing analysis is needed to examine the supply and condition of existing housing, the housing production capacity of the area, the availability of mortgage credit and the quantity of housing needed to accomodate growth. Local zoning has not been thoroughly investigated for effects it might have on coal development or development of communities to accomodate population growth. Secondary economic effects have not been included in the analysis.

TABLE 3
SUMMARY COMPARISON OF IMPACTS FOR STUDY SCENARIOS

Low Production Level (5 MTY) Truck Haulage *"See Brown Section"*	Medium Production Level (54 MTY) Slurry Pipelines & Railroad *"See Beige Section"*	High Production Level (84 MTY) Slurry Pipeline & Railroads *"See Green Section"*	Significant Data gaps
	the employment structure of the area economy. It is assumed that a new town of 31,000 people would be built near Glen Canyon City.		
	Socio-Cultural		
Coal development would result in population growth of small communities and would result in some changes in local lifestyle but none of the changes would be significant under low scenario. Least significant socio-cultural impacts are likely to occur in Cedar City, St. George and Page. Most significant impacts would occur in small rural communities of Kane and Garfield. Positive impacts to all communities would occur under this scenario because former residents and children of current residents would return because of new employment opportunities.	Coal development would result in "boomtown" conditions in Garfield and Kane Counties. There would be significant increases in social problems such as local crime rates, truancy and delinquency, increased drinking and drug abuse, and more frequent occurrences of family problems.	Impacts would be similar to medium scenario but greater in magnitude.	None
	Noise		
Construction and operation of the mines would produce noise levels between 75 and 95 dBA (at 50 feet). However, the noise levels would not exceed levels associated with normal construction activities. Additional truck traffic would create noise levels within accepted noise standards, except under worst-case nighttime conditions near sensitive receptors such as hospitals.	Same as low production level for the mine construction and operation. However, there would be increased noise levels associated with construction of the coal slurry pipeline or railroad but the noise levels would not exceed acceptable noise standards. No significant noise impacts would be associated with operation of the slurry pipeline. Rail lines would pass sensitive receptors but traffic volumes at the medium production level would maintain noise levels at an acceptable level.	Same as medium production level except that the largest rail traffic would occur with this scenario. A train pass-by could occur every 35 minutes on the route from South Kaiparowits to Milford. This would result in noise levels exceeding acceptable standards. Under worst-case conditions, night-time sound levels could be above 55 dBA for a distance of 3 miles and exceed maximum levels for sensitive receptors such as hospitals.	None

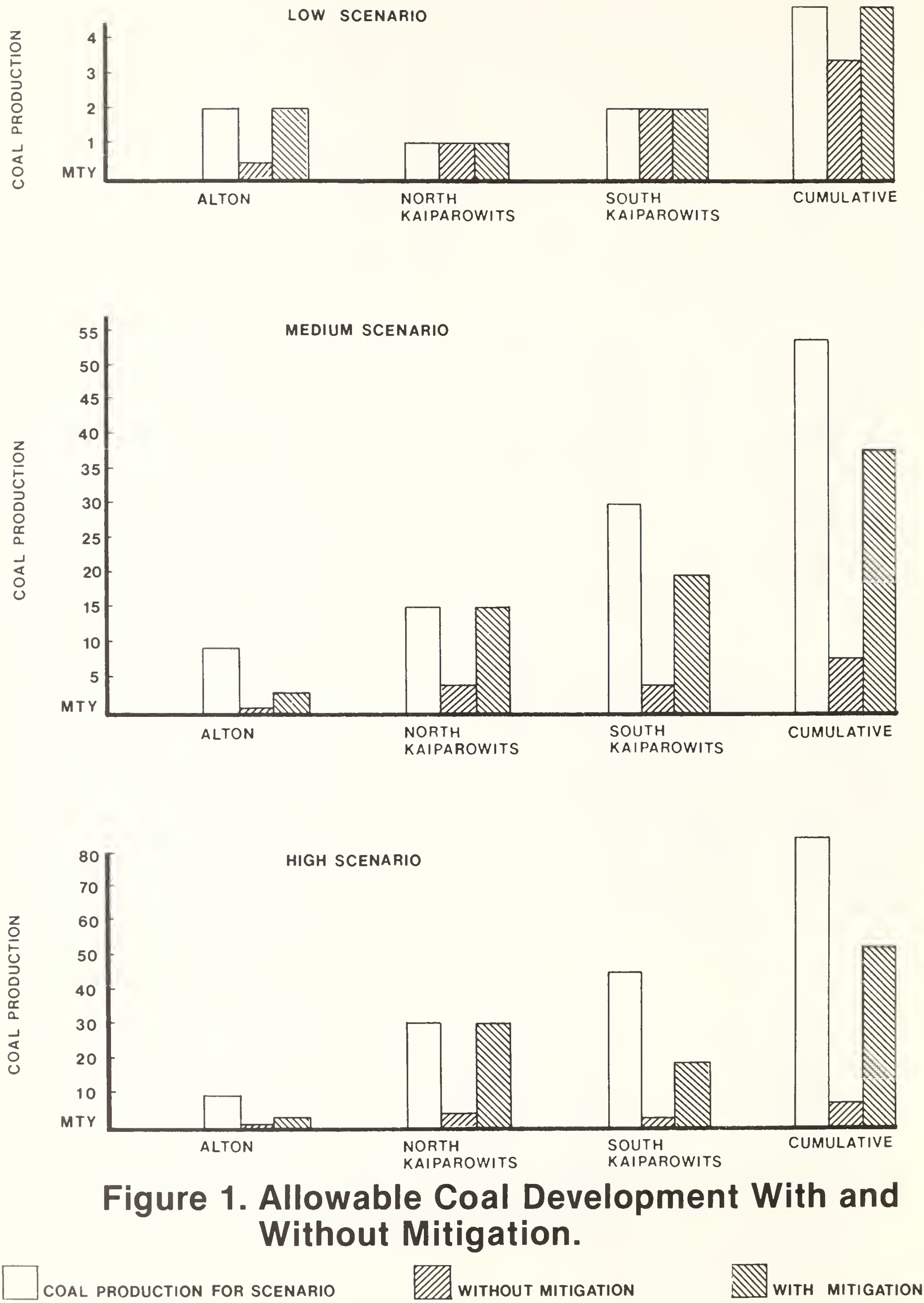

Figure 1. Allowable Coal Development With and Without Mitigation.

The amount of coal production that could be developed for each scenario before the most stringent TSP air quality standard would be violated can be seen in Figure 1. Figure 1 shows the fraction of coal development by scenario for each lease area with and without 88 percent effective mitigation measures. As shown, 88 percent mitigation would be quite effective and would allow for the following coal development:

- Development of all coal under low scenario (5 MTY)
- Development of approximately 70 percent (38 MTY) of coal under the medium scenario
- Development of approximately 62 percent (52 MTY) of coal under the high scenario

Visibility

Visibility is a major concern in the study area because of the important scenic values and National Parks. Increase in TSP concentrations as a result of coal development and transportation would degrade the visual range. The vistas looking from Bryce Canyon National Park towards Navajo Mountain are the most sensitive to changes in visibility. The emission reduction (presented in the Air Quality section of this report) necessary to meet PSD increments and NAAQS for dust, would also reduce emission effects on visibility. At the low production level, modeling results indicate that the projected visibility impacts can be mitigated. However, at the medium and high production levels, the modeling results indicate that the mean visual range would be reduced by 12 percent to 177 kilometers (110 miles) with the mitigation measures assumed in the Air Quality section. Navajo Mountain would be visible from Bryce Canyon National Park about 50 percent of the time as compared with 70 to 80 percent of the time at present. Additonal mitigation measures for TSP would further limit reductions in visual range. If no mitigation measures were applied to coal development and transportation, the visual range from Bryce Canyon National Park to Navajo Mountain would be decreased about 45 percent (from 200 to 109 kilometers or 124 to 68 miles) for the medium production level and 75 percent (from 200 to 49 kilometers or 124 to 30 miles) for the high production level. Figure 2 summarizes the potential visibility effects.

Currently there are no visibility standards for PSD Class I areas such as Bryce Canyon and Zion National Parks. Regulations have been proposed by the Environmental Protection Agency which would give state and Federal Land Managers responsibility for administering visibility through involvement in the permitting process. Under proposed regulations, if the Federal Land Manager believes that visibility would be adversely impacted, even though the PSD increment is met, he provides documentation to the state for their consideration in their permit process.

Water Resources

Groundwater resources are scarce in the study area and there has been concern expressed by numerous parties about the water requirements for coal development and transportation (primarily coal slurry pipeline) and subsequent impacts on groundwater resources and existing wells. Based on the results of the groundwater modeling conducted during the study, it was concluded that water requirements for slurry pipelines would reduce the groundwater levels in the Navajo Sandstone. The water level drawdown (lowering of the water table) in the Navajo Sandstone for the Alton lease area under the medium and high scenarios is estimated to reach 350 feet. The regional effect would be a 1-foot drawdown level of the cone of depression extending to a maximum radius of 11.8 miles. Similar effects would be observed in the North Kaiparowits lease area under the medium scenarios where drawdown would reach 450 feet and the 1-foot drawdown level of the cone of depression would extend an estimated radius of 12.7 miles (see Map 3-3 and Figure 4-18).

The overall drawdown in the Navajo Sandstone would not affect existing wells which are located in shallower aquifers. The groundwater reduction in the Alton area would impact the East Fork of the Virgin River and reduce its flow in the Alton area by between 25 and 50 percent after 40 years of pumping. Reduction of flow would adversely affect the Virgin River aquatic ecosystem by reducing the amount and stability of aquatic habitat. Pumping at Alton would also eventually reduce output or interrupt flows of Johnson Canyon Springs.

Wilderness Resources

Development of coal and coal transportation facilities in accordance with the study scenarios would conflict with potential wilderness areas and wilderness study areas at several locations in the Kaiparowits study area. An area of the Dixie National Forest in corridor segment C1 has been recommended

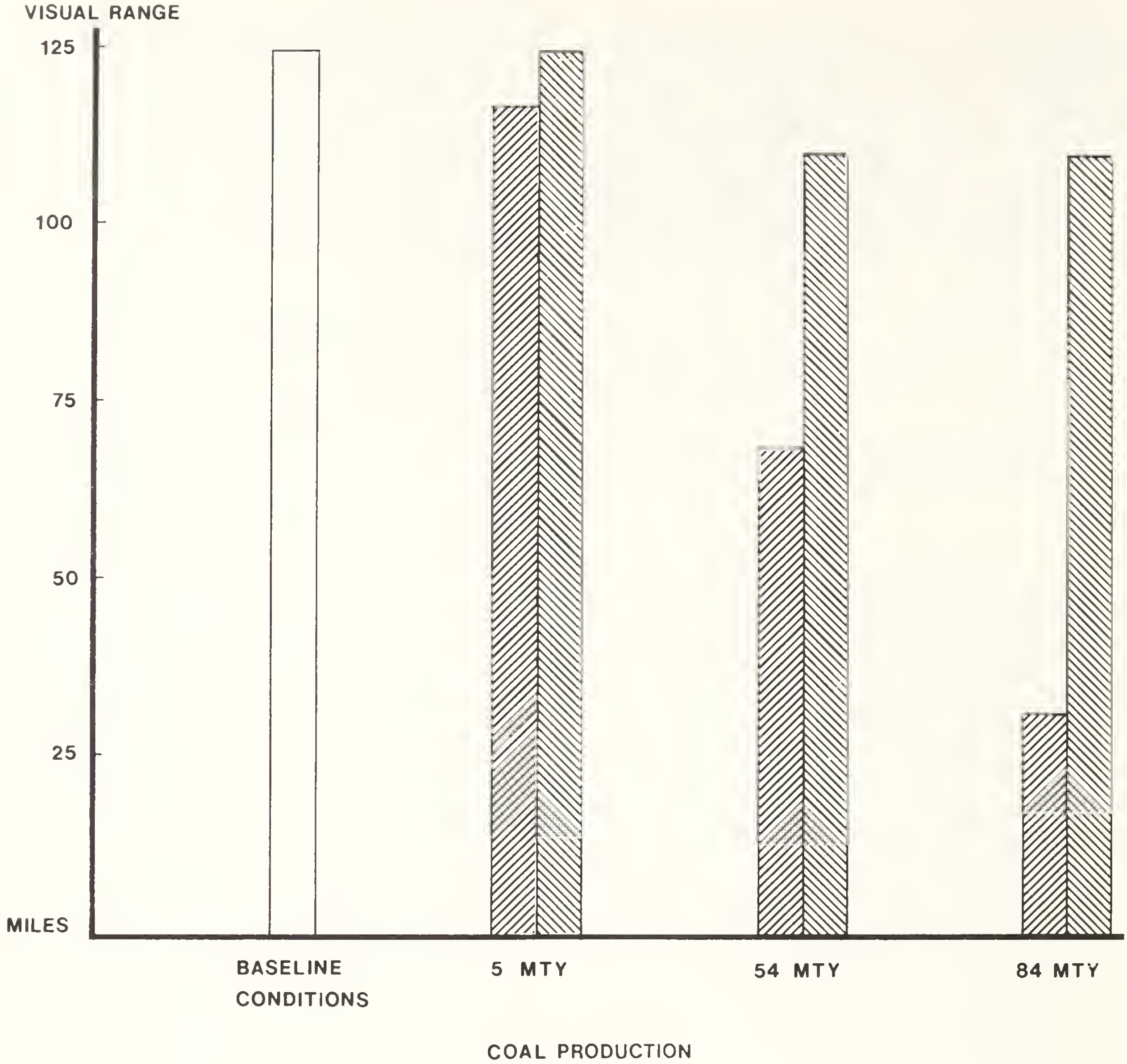

Figure 2. Visual Range - Bryce Point to Navajo Mountain (Exceeded 50% of the Time)

by the USFS to Congress for designation as a wilderness area (see Map 3-8). In addition to the USFS wilderness proposal, the BLM has proposed designation of lands as wilderness study areas on significant portions of corridor segments C6, C7, C10, C13, C14, and C15 and on approximately 10 percent of the South Kaiparowits lease area (Map 3-8). BLM wilderness study areas will be finalized by November 15, 1980. Lands so designated will be managed "... so as not to impair their suitability for preservation as wilderness..." (U.S.D.I., BLM 1979) until Congress has acted on presidential recommendations regarding the wilderness study areas. If wilderness study areas are designated, it will require further planning and environmental impact statements prior to a decision by the Congress of the United States. Since the Secretary of the Interior has until October 1991 to make wilderness recommendations to the President and the President is not required to report his subsequent recommendations to Congress until October 1993, wilderness study areas would be managed under restrictions imposed by Section 603 of the Federal Land Policy and Management Act until the mid-1990s. Throughout the BLM planning process, conflicts are identified. Recommendations are then made to Congress as to boundary adjustments or suitability of areas based on resource conflicts (such as energy development and transportation). BLM hopes to complete wilderness planning and EIS preparation before the 1991 deadline.

BLM Interim Management Policy (U.S.D.I., BLM 1979) for lands under wilderness review limits granting of new rights-of-way across such lands and greatly restricts mineral development uses. The most significant conflicts between proposed wilderness study areas and transportation planning corridors occur in corridor segments C10, C13, C14, and C15 where terrain acts in combination with the proposed wilderness study areas to greatly restrict possible development of rail and slurry lines. Corridor segments C1, C6, and C7, although greatly narrowed by the proposed wilderness study areas, would be less significantly affected because the most accessible terrain for construction of rail or slurry lines is not recommended for further wilderness review.

Transportation

The highway system in the study area is designed primarily for traffic volumes associated with rural areas. Development of coal in the study area at the medium and high scenarios would generate significant increases in vehicle traffic. Therefore, development at these scenarios would result in significant adverse transportation impacts. Cumulative coal production traffic generated from the Kaiparowits and Alton lease areas under the high scenario would result in significant impacts to the regional transportation systems. The traffic volume on many segments of U.S. 89 would exceed Utah Department of Transportation (UDOT) volume standards resulting in traffic congestion, delays, and reduced operating speeds. In addition, the theoretical capacity for a two-lane highway would be exceeded for U-12 near Escalante.

Additional coal-related traffic would increase the potential for accidents. It is estimated that approximately 350 to 370 additional accidents per year would result within the study area under the high scenario. The operations of unit coal trains would delay traffic flows and create a potential for vehicle-rail accidents.

Socioeconomics

Development and transportation of coal resources in the Kaiparowits region would greatly increase the population in the study area at all development levels. By the year 2000, the baseline population of Kane and Garfield Counties is expected to grow from 9,400 to 16,300. The same two counties would realize most of the population impacts from coal development. Their combined population in the year 2000 with coal development is projected at 22,925 for low level, 71,298 for the medium level, and 104,671 for the high level development scenario. The population of Page, Arizona, would also be significantly affected. Whereas the baseline population in 2000 is projected at 4,878, coal development at the low, medium or high scenario levels would increase that to a projected 7,629, 8,734, and 10,542, respectively. Of greatest significance, much of the population growth would occur in a 5-to 8-year period, qualifying even the low development scenario as a very rapid growth condition. The most extreme growth example would be the assumed New Town on East Clark Bench where no current population exists. The New Town is projected at 45,315 people by the year 2000 under the high coal development scenario. The existing town of Cannonville would realize growth under the high level scenario to as much as 26 times the projected baseline population in the year 2000 when the population would begin to stabilize. Several other communities would observe populations 10 times the baseline level or more (see Figure 3).

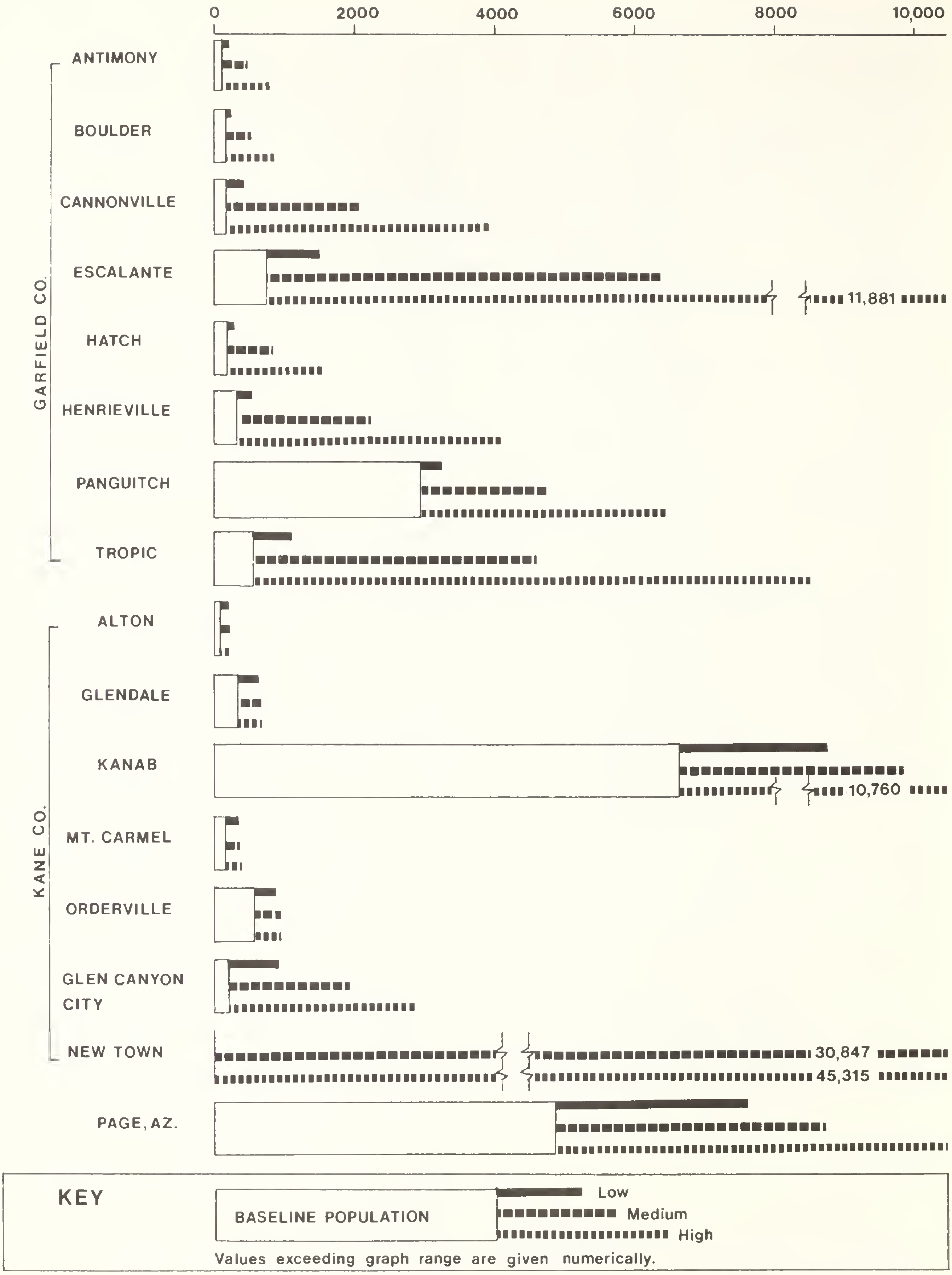

Figure 3. Population Projections Showing Growth Associated with Three Levels of Coal Development — Year 2000.

Significant effects would be expected on the fiscal resources of Kane and Garfield Counties and all communities studied. Assuming the continuation of current tax rates and fee structures, operation and maintenance expenditures would exceed revenues for all communities under all scenarios, including the baseline. These shortfalls would be relatively minor for the baseline, but for the medium and high coal production levels, they would require increases in tax rate structures to as much as 3 times current rates in some cases. In addition to the operational shortfalls, many communities would require major capital outlays under the medium and high coal production scenarios to provide water and sewer systems, schools, hospitals, and other community facilities needed for greatly increased populations. The capital facilities problems would be further aggravated by the need to build facilities before the major increase in population and, thus, before any substantial growth-related revenue increases would be realized. The fiscal situation regarding the assumed new town in Kane County is uncertain because no sponsor for development of the community has been identified. Fiscal impacts on communities beyond Kane and Garfield counties in Utah and on Fredonia, Arizona, would be relatively short-lived and less significant. No analysis was conducted for Page, Arizona, but impacts similar to those identified for Kane and Garfield County communities would be expected.

County fiscal impacts would be the reverse of community impacts. Due to the rural location of coal development and transportation facilities, tax bases would be substantially enlarged. However, counties provide relatively few services, so expenditures would not grow proportionately. Thus, minor operating and maintenance shortfalls would be expected for the baseline, but excess revenues would be realized for all coal development levels ranging up to several million dollars per year at the high level.

The economy of the study area would be altered by all levels of coal development due to changes in the employment structure and above average wage levels for mining and transportation employees. By the year 2000, direct mining employment alone would range from 6 percent of the total projected baseline employment at the low level, to 39 percent at the medium level, to 64 percent at the high production level. At the medium and high levels, mining would become the dominant economic sector in the area economy. High wage levels for mining related employees in a boom economy would permit them to pay high prices for scarce goods and would thus tend to force up prices for all residents. Certain current residents, especially those on fixed incomes, would not be able to maintain their economic standard of living.

FUTURE PLANNING EFFORTS

This study has provided information to help the appropriate Federal and state land managers, local agencies, industry, and public interest groups address the important policy questions relative to potential mining and transportation of coal in the Kaiparowits region. While this study does not address impacts of site-specific projects, it can serve as a planning guide for determining policy for production and transportation of coal. In addition, this report along with detailed supportive information will allow Federal and state land managers to generally evaluate impacts of future site-specific proposals and to determine if potential projects meet subsequent environmental policy developed by various agencies.

It should be noted that the document provides a great deal of flexibility for the evaluation of combinations of development levels and transportation modes not specifically identified in the scenarios. Such combinations could include various mixes of low, medium, and high production levels at the three lease areas, rail transportation out of the Alton lease area, coal slurry pipeline transportation out of the South Kaiparowits lease area, or various mixes of transportation modes and destinations. Preliminary evaluations of possible combinations based on this report would allow land managers to determine general impacts prior to conducting detailed site-specific studies.

Along with describing regional environmental impacts, this report also identified environmental "fatal flaws" which should be avoided in development of coal in the region, and major data gaps which could affect the ultimate production and transportation of coal (Table(3). These data gaps should be filled when a site-specific proposal is evaluated. Coordination of appropriate future planning efforts and interagency coordination (Federal, state, and local) could be quite effective in dealing with the major data gaps and ensuring that appropriate mitigation measures identified in this report are implemented.

Specific interagency coordination and future planning efforts should be initiated for the six significant environmental issues

previously identified in this summary. These efforts could proceed immediately or concurrently with the review of site-specific proposals and should include the following:

- *Air Quality and Visibility.* The National Park Service (NPS), Environmental Protection Agency (EPA), Bureau of Land Management (BLM), Office of Surface Mining (OSM), and State of Utah should work together to define existing visibility, determine potential impacts to visitor use as a result of decreased visibility, and assure that specific air quality mitigation measures suggested in this report are implemented to achieve an 88 percent reduction of TSP emissions.
- *Water Resources.* The BLM, OSM, U.S. Geological Survey (USGS) and State of Utah should initiate additional groundwater modeling studies and field testing programs to determine storage coefficients and recharge capabilities of the Navajo Sandstone.
- *Wilderness.* The BLM, OSM, state, and industry should work together to expedite the review of wilderness study areas which could restrict the development of coal transportation facilities. This review could answer many questions for BLM and industry planners and help to determine the feasibility of coal development.
- *Socioeconomics.* The State of Utah and Five-County Association of Governments, along with appropriate affected counties and towns, should undertake land use, housing, and zoning analyses and indicate where "front-end" money for planning analysis is necessary. Planning should develop measures to accomodate growth and reduce significant socioeconomic impacts associated with rapid growth.
- *Transportation.* The Forest Service, NPS, State of Utah, and BLM should initiate a cooperative program to determine policy on the location of new roads associated with coal development transportation. Specific mitigation measures to reduce TSP emissions from rural roads should be identifed.

The existing Federal, state, and local agency Kaiparowits Steering Committee should be continued to ensure that appropriate interagency coordination and future planning efforts are implemented. The committee should be expanded to include representation from the OSM, EPA, and counterparts in state government. This is important because OSM has authority to approve site-specific mining and reclamation plans and EPA is involved in the approval of PSD applications.

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CHAPTER 1

INTRODUCTION

BACKGROUND

The Federal Land Policy and Management Act of 1976 (FLPMA) and the National Environmental Policy Act of 1969 (NEPA) require that the Bureau of Land Management (BLM) provide for multiple use development and management of resources with consideration and protection of environmental values.

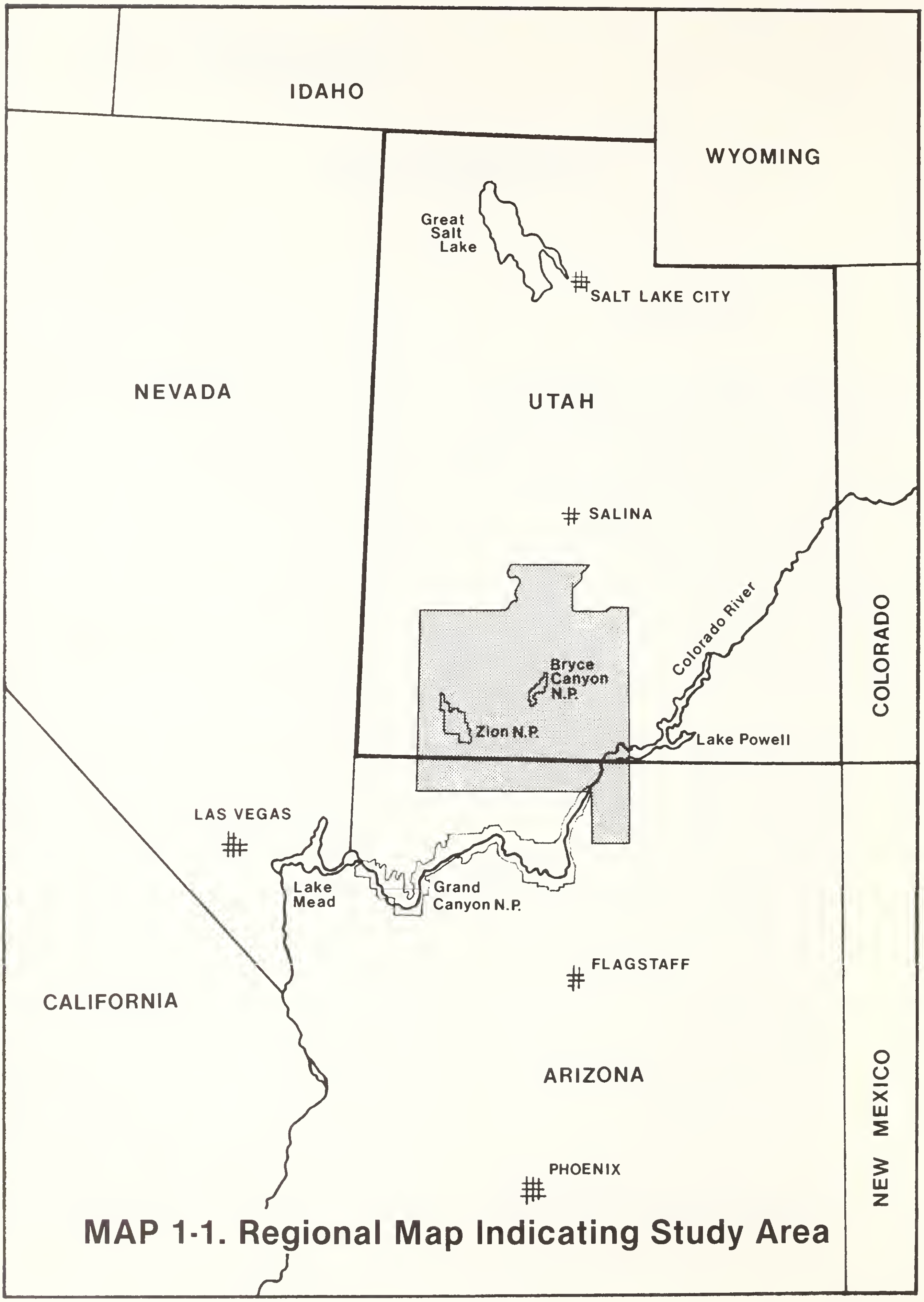
The Kaiparowits Coal Development and Transportation study resulted from an agreement made by the Secretary of the Interior and Governor Scott Matheson of Utah for a cooperate study by the Department and the State of Utah to review the issues raised by potential mining and transportation of coal from the Kaiparowits Plateau. The study concentrated on the following questions:

1. Would the physical impacts from mining Kaiparowits coal cause unacceptable damage to National Park, National Forest, or Bureau of Land Management (BLM) lands?
2. Would the physical impacts of coal transport by rail or coal slurry pipeline within corridors to be identified by the study be inconsistent with preservation of National Park or other Federal land values?
3. How might the population increases that could result from mining affect the use of National Parks and other Federal lands, and what land management steps should be considered to protect the National Parks and other areas from damage that might be caused by increased population?
4. How should Federal resource management decisions—Wilderness, Areas of Critical Environmental Concern, Class I air quality designation, identification of potential transportation corridors or community sites—be coordinated?

The Southern Utah Regional Coal Environmental Statement (U.S.D.I. Geological Survey 1979) describes the environmental impacts of various mining plans and coal production levels in the region. However, that statement does not focus in detail on all aspects of coal production and transportation. Therefore, it was determined by the Governor and the Secretary that additional analysis was necessary to identify impacts associated with coal transportation. The study area generally includes the Kaiparowits Plateau, the Alton coal field, and a small portion of northern Arizona (see Map 1-1). It comprises the majority of the known coal resources of Garfield and Kane Counties, Utah.

Three geographic coal lease groups have been identified within the study area for purposes of the study; the Kanab Coal Field southeast of Cedar City was not considered. The areas studied were the North Kaiparowits, South Kaiparowits, and Alton lease areas and are shown on Map 2-1. Coal transportation corridors have been identified and are also shown on Map 2-1. It is anticipated that any future proposals for specific transportation and utility systems would be narrowly defined and located within the boundaries of the transportation planning corridors identified in this study.

A Steering Committee was established by the Governor and the Secretary to insure agency coordination and input to the Kaiparowits Coal Development and Transportation Study. This committee includes representatives of the National Park Service, Bureau of Land Management, Forest Service, Utah State Planning Coordinator's Office, Utah Department of Natural Resources, and the Five-County Association of Governments. The Steering Committee provided support to the BLM in a guidance and review capacity throughout the Kaiparowits study. Coordination meetings were attended by the BLM, Steering Committee, and ERT at regular intervals during the course of the study.



MAP 1-1. Regional Map Indicating Study Area

PURPOSE AND OBJECTIVES OF THE STUDY

The product of this study is a regional planning document. Information developed will provide a foundation to help the state and Federal land managers address important policy questions. The study will help the Department, state and local agencies, and the general public understand basic issues such as whether designation of rail or slurry transportation corridors would conflict with National Park or other Federal land management policies. The study will stimulate participating agencies to perform their own analyses of these questions. The study does not look at issues related to mine-mouth use of Kaiparowits coal or economic feasibility of Kaiparowits coal development. Any such end-use questions would be addressed in site-specific environmental impact statements resulting from mine development or transportation rights-of-way applications to BLM, the Office of Surface Mining (OSM), and other agencies. Federal and state land managers can utilize this report to make a preliminary assessment of the acceptability of impacts and identify mitigation measures or management steps that could be considered.

It should be noted that the issue of need for coal development on the Kaiparowits Plateau is not being addressed as a part of this study. Present and future demands for coal, potential coal markets, and alternative coal sources in the western United States were not included in the scope of this study as it was defined by the Department of the Interior.

The study also provides new environmental analyses (including trade-offs and residual impacts) specifically directed at coal transportation via various planning corridor alternatives. It combines information and analysis in one report, including narrative presentation, graphics, and appendices, in such a manner as to be technically correct and yet readily understood by a non-technical reader. Where appropriate, environmental and technical data gaps and opportunities for interagency coordination are identified.

Since the Kaiparowits Coal Development and Transportation Study is a regional planning study, this report does not present a detailed discussion of certain potential impacts. However, a detailed analysis would be conducted as part of any site-specific environmental impact statement prepared for a mining plan and/or right-of-way application. The primary intent of the report is to inform the public and decision makers of the most significant impacts, issues, and trade-offs involved with various levels of coal production and transportation in the Kaiparowits region of southern Utah. This information can then be used by Federal, state, and local governments, interest groups, and the general public to determine whether or not various mining locations, coal production levels, and transportation modes are acceptable within the region. This report objectively presents potential impacts and avoids making value judgements about the desirability of coal development or the acceptability of impacts.

INTERRELATIONSHIPS

The Kaiparowits Coal Development and Transportation Study is one of a series of studies which has been conducted in southern Utah during the past decade. Two Environmental Impact Statements have been completed in this region and three others are currently being prepared. This section describes the relationship of the Kaiparowits study to these EISs and current Federal land planning activities.

Environmental Impact Statements

- *Kaiparowits Project Environmental Statement*—A FEIS was prepared in 1975 on a proposed 3,000-megawatt (MW) coal-fired electric generating station, coal mine, and related facilities on the Kaiparowits Plateau in Southern Utah. The applicants subsequently withdrew their various permit applications and the project was abandoned.
- *Development of Coal Resources in Southern Utah Environmental Statement*—The FEIS was prepared in 1979. The proposed actions were based on three proposed mining and reclamation plans to produce coal from eight mines on Federal lands in southern Utah. The statement was prepared in two parts. The first part (Regional Analysis) evaluated the cumulative impacts of four coal production scenarios, while the second part (site-specific analysis) specifically evaluated each proposed action. None of the mining and reclamation plans have been approved by the Office of Surface Mining (OSM).
- *Allen-Warner Valley Energy System Environmental Impact Statement*—The DEIS was prepared in June 1980 on a proposed 2,500-MW coal-fired steam electric generating system. The proposed energy system includes surface and underground mines in the Alton

Coal Field, a coal processing facility near Bald Knoll, a coal slurry pipeline, the Harry Allen steam-electric generation station (2,000 MW), the Warner Valley Station (500 MW), and the Warner Valley Water Project. The FEIS is scheduled for October 1980.

- *Alton Coal Unsuitability Petition Environmental Impact Statement*—On November 28, 1979, an unsuitability petition for the Alton Coal Field was filed with OSM under Section 522 of the Surface Mining Control and Reclamation Act. The petition was filed by the Environmental Defense Fund, Friends of the Earth, Sierra Club, and seven private landowners. Some of the critical issues raised in this petition were potential effects on the quantity and quality of groundwater and surface water; potential visual intrusion as observed from Yovimpa Point in Bryce Canyon National Park; potential air quality/visibility impacts; and potential impacts to pinnacles in Bryce Canyon resulting from blasting. The OSM is currently preparing an EIS on this petition. The Draft Statement is scheduled for release on August 20, 1980, and public meetings on the DEIS will be held on September 29 and 30. The final EIS will be released on November 13, 1980, and the Secretary of the Interior will make a decision on November 28, 1980.
- *Unita-Southwestern Utah Regional Coal EIS*—The Bureau of Land Management (BLM) is in the process of preparing a Regional Coal EIS for the Unita-Southwestern Utah coal region. This EIS does not affect the study area with the exception of some preference right lease applications in the North Kaiparowits lease area. Utah Power and Light International, Inc. has proposed to trade existing preference right lease applications on the Kaiparowits Plateau for federal leases southwest of Price, Utah. This EIS will consider the possible exchange. The draft environmental statement will be released on September 12, 1980, and the final EIS will be released on February 1, 1980.

Future of Coal Leasing in Southern Utah

The study area contains a substantial amount of coal reserves. Total coal reserves for the Kaiparowits and Alton coal lease areas have been estimated to be around 17.3 billion short tons. A significant amount of the Federally owned coal has already been leased (approximately 247,300 acres). While some development has been proposed for the leases (Southern Utah Regional Environmental Statement, U.S.D.I., Geological Survey 1979), there has been no development to date.

Because of the extensive amount of Federal coal already leased in the study area, BLM has not scheduled any future coal leases for Federally owned coal in the study area. Once a decision is made to lease additional land in the study area, competitive leasing would be accomplished following the regulations and procedures for Federal Coal Management (43 CFR 3420). Competitive leasing is a component of the Federal Coal Management program and consists of four principal elements: (1) comprehensive land use planning; (2) establishment of regional leasing targets; (3) tract delineation, ranking, selection, and scheduling; and (4) lease sale. It is not anticipated that additional competitive leasing would occur in the study area for several years.

Relationship To Land Use Plans

BLM Planning

The Management Framework Plans (MFP) for the Cedar, Garfield, Escalante, Paria, Zion, San Rafael, and Henry Mountain Planning Units include the entire southern Utah coal region and were completed from 1971 to 1975. A MFP Supplement was prepared for the Escalante, Paria, and Zion Planning Units in March 1980. The Supplement contains the results of the application of the coal unsuitability criteria, multiple use planning recommendations involving coal conditions or stipulations that may be imposed on future coal leases or mining plans, and surface-owner consultation.

Forest Service (USFS) Planning

The USFS plan governing management in the study area is included in the Paunsaugunt-Sevier, Aquarius, and Boulder Land Management Plans (LMP). A draft Paunsaugunt-Sevier LMP and EIS was published in 1979. The Aquarius and Boulder LMP were published in October 1973 and April 1975, respectively. The following management direction relating to coal development is found in the LMPs:

- Prohibit enlarging the road through Red Canyon on the Paunsaugunt Plateau beyond the present right-of-way.

- Restrict utilities corridor to the canyon south of Wilson Peak and westward toward Hillsdale.
- Protect and maintain vistas from Henderson Rim during development of the Jesse Knight property.
- Allow no mining operations on the Jesse Knight property within view of Pine Lake Recreation area.
- Allow limestone development if scenic views from Powell Point are protected.
- Manage exploration and development of mineral and energy resources to protect esthetics and scenic views from the proposed Table Cliff Scenic Area.

National Park Service (NPS) Planning

Management objectives for the Glen Canyon National Recreation Area relating to coal development or transportation of coal include (U.S.D.I., National Park Service (1979a):

- Propose a utility planning corridor below the dam for the location of transportation and (or) utility systems.
- Manage the Escalante River drainage as wilderness. Utility rights-of-way would not be permitted in this wilderness and natural zone.
- Manage to provide intensive water-recreation use and visitor services and maintain facilities at Wahweap/Lone Rock and Warm Creek areas. These areas are designated development zones which are existing developed areas with relatively elaborate and permanent structures necessary to support recreational activities. Mining is prohibited; however, utility structures are permissible.
- Close the area of Hall's Creek to vehicles in Capitol Reef National Park and Glen Canyon NRA and restore the area as nearly as possible to its natural state.
- Make a concentrated effort to acquire all lands and interests in the lands, including mineral interests within the parks.
- Establish a system for the protection and enhancement of the cultural environment; preserve, restore and maintain objects of historical, architectural, and archeological significance.

Management objectives for Bryce Canyon National Park include (U.S.D.I., National Park Service 1976b):

- Cooperate with outside agencies, organizations, and members of the public in assuring, to the greatest extent possible, that nearby lands are developed and managed in ways that are compatible with preserving the park's air and water quality, geological resources, ecological communities, and the scenery for which the park is famous.
- Protect and enhance the natural and scenic values of the park by eliminating incompatible park uses and by providing an adequate land base to permit achievement of the park's purpose.

Management objectives for Zion National Park include (U.S.D.I., National Park Service 1976):

- Continue observations to determine the effects of heavier visitor use and the changing land use practices in the surrounding area on air and water quality, wildlife, and plant life.
- Maintain the quality and flow of water from all natural water sources that have been traditionally important in serving domestic needs and in perpetuating the Park's ecological communities.
- Cooperate with other governmental agencies, local communities, private organizations, and members of the public in:

  1) Ensuring that grazing, logging, mining, summer home development and other land uses in the Park's immediate vicinity are compatible, to the greatest degree possible, with long-term perpetuation of the Park's scenic and natural values.
  2) Ensuring that energy development in the Park's airshed is implemented in a manner that preserves existing air quality in the Park.
  3) Studying and monitoring air and water quality in the Park's airshed and watershed in order to develop programs for their improvements.

Potential Development Projects

There have been several potential projects prepared for the study area but to date no formal applications have been submitted except for the Allen-Warner Valley Energy System. The projects tentatively identified in the Southern Utah Regional EIS are as follows: Kaiparowits Gasification Plant (Nipple Bench), Garfield Power Generating Plant (8 miles south of Escalante), and a Power Generating Plant (4 miles southeast of Escalante).

CHAPTER 2

STUDY SCENARIOS AND TRANSPORTATION CORRIDORS

OVERVIEW

Unlike an environmental impact statement (EIS) which has a set of distinct alternatives for evaluation, the Kaiparowits Coal Development and Transportation Study does not have a specific development proposal or "proposed action" on which to base impact analysis. Therefore, it was necessary to develop study scenarios which included different levels of coal development, mining methods, and transportation modes. In addition, it was important to select transportation planning corridors within the study area.

This chapter is divided into three major sections. The first section describes the study scenarios along with the rationale used to determine the coal production levels. The second section describes the transportation corridors along with the rationale for the selection of corridors. The last section provides a general description of construction and operation activities for various types of mining and transportation modes analyzed in this study. This section is provided to acquaint the reader with sources of potential environmental impacts associated with the development and transportation of coal in the study area.

STUDY SCENARIOS

As previously indicated, three study scenarios which would define the potential types of development in the study area were identified (Table 2-1). These scenarios deal primarily with coal production levels, mining methods, coal transportation modes, and development employment levels. Tables 2-2 and 2-3 present coal development and transportation employment assumptions for the study scenarios. The rationale for the coal production levels is subsequently described in detail. Other detailed assumptions which were utilized for impact analysis are presented in Chapter 4 of this report.

Rationale for the Selection of Coal Production Levels

The coal production levels chosen for evaluation in this study were based on two major considerations: (1) the capacity of the specific coal transportation modes and; (2) the diligent development requirements contained in the Code of Federal Regulations as applied to the existing coal leases. ERT contacted many sources of information before recommending to the Steering Committee eight coal production levels for analysis. These included BLM specialists, National Park Service personnel, Utah Department of Transportation personnel, Utah Geological & Mineral Survey personnel, Union Pacific Railroad representatives, and El Paso Coal Company representatives. In addition, information contained in the Southern Utah Regional Coal ES, the Allen-Warner Valley EA, and other materials collected for the Kaiparowits study were reviewed. The controlling transportation assumptions which were developed were that 25-ton net load coal haul trucks would be utilized and that coal production of 30 million tons per year (MTY) would be required to amortize a railroad into the Kaiparowits region.

As of the date of this study, coal reserves in the Alton and South Kaiparowits lease areas are under Federal leases, while reserves in the North Kaiparowits lease area are covered by preference right lease applications (PRLA). For the purpose of this study it was assumed that these PRLA lands would be leased by December 31, 1984. All holders of Federal coal leases must meet diligent development requirements given in the Code of Federal Regulations 43 CFR 3500.0-5(f). Diligent development requires the timely preparation for and initiation of the production of coal from the logical mining unit (LMU) of which the lease is a part. Coal must actually be produced in commercial quantities within a ten-year period. The minimum annual production

TABLE 2-1
STUDY SCENARIOS

Lease Area	Coal Production (10^6 T/yr.)	Mining Method	Transportation Mode
Low Level			
Alton	2	surface	truck
North Kaiparowits	1	underground	truck
South Kaiparowits	2	underground	truck
TOTAL	5		
Medium Level			
Alton	9[a]	surface & underground	slurry pipeline
North Kaiparowits	15[b]	surface & underground	slurry pipeline
South Kaiparowits	30	underground	rail
TOTAL	54		
High Level			
Alton	9[a]	surface & underground	slurry pipeline
North Kaiparowits	30[c]	surface & underground	rail
South Kaiparowits	45	underground	rail
TOTAL	84		

Source: ERT Project Team Years

[a]Years 1-20 all surface mining
Year 21, 75% surface, 25% underground
Year 22, 50% surface, 50% underground
Year 23, 25% surface, 75% underground
Years 24-40, all underground mining

[b]2 million tons/year surface mining
[c]3 million tons/year surface mining

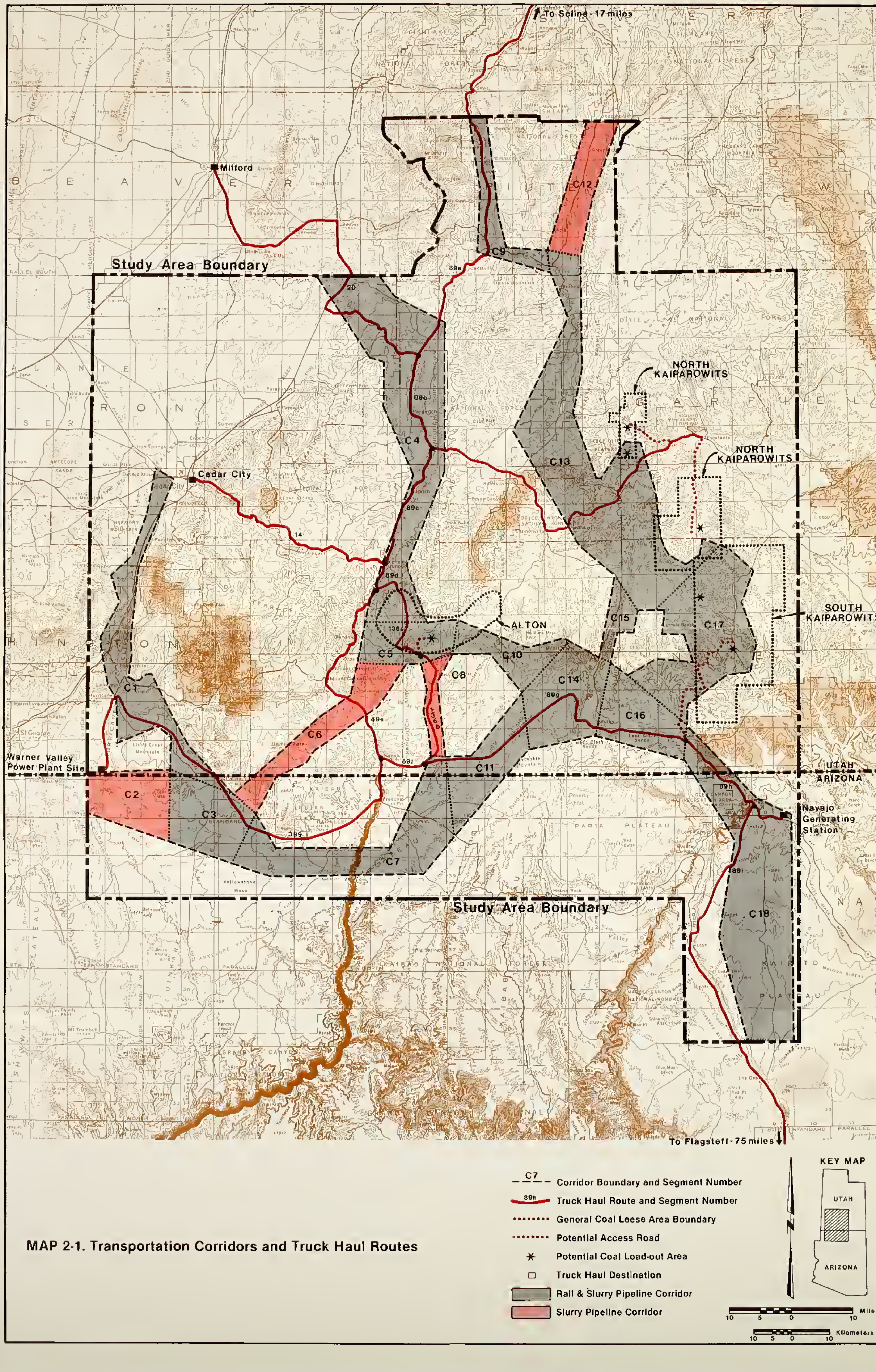
required is 1 percent of the coal reserves in the LMU or 1/40th of these reserves for old leases. This means that production in commercial quantities must commence before June 1, 1986, in the Alton and South Kaiparowits lease areas. An extension of time could be provided in accordance with 43 CFR 3520.2-5. Production in the North Kaiparowits lease area would be required by 1994. Failure to meet diligent development requirements could result in forfeiture of leases.

A point of controversy concerning the commercial coal production levels needed to meet the diligent development requirements was identified. This controversy centered around the size of the proven coal reserves present in the North and South Kaiparowits lease areas. The larger the proven reserves, the higher the required production levels. ERT based its diligent development production levels on U.S. Geological Survey (USGS) estimates of reserves and BLM analysis of required production. This analysis resulted in the coal production levels summarized in Table 2-4 and was part of the BLM's original request for proposal (RFP).

Considering all the information reviewed, ERT felt that the coal production levels outlined in the RFP were higher then one might reasonably expect for the Kaiparowits region. Therefore, within the general restrictions of transportation mode capacities and diligent development requirements, the Steering Committee approved more conservative production levels for the three lease areas. For example, the high production level for the North Kaiparowits lease area was based on the more conservative level needed to amortize a railroad rather than the higher 1/40 diligent development level. The rationale for each of the other coal production levels is summarized in Table 2-5.

DESCRIPTION OF TRANSPORTATION CORRIDORS AND TRUCK HAUL ROUTES

The coal transportation corridors and truck haul routes utilized in the study are presented on Map 2-1, and the rationale for this selection follows. There are 18 transportation corridor segments (C1 through C18) and 16 truck haul route segments (12, 14, 20, 89a through



MAP 2-1. Transportation Corridors and Truck Haul Routes

TABLE 2-2
COAL PRODUCTION EMPLOYMENT ASSUMPTIONS FOR POPULATION PROJECTIONS

	Alton			N. Kaiparowits			S. Kaiparowits		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Production Level	2MTY[1] (s)[2]	9MTY (s)	9MTY (s)	1MTY (u)[3]	15MTY (2-s, 13-u)	30MTY (3-s, 27-u)	2MTY (u)	30MTY (u)	45MTY (u)
Employment:[4]									
Operations	120	540	540	290	120(s) 3,770(u)	180(s) 7,830(u)	580	8,700	13,050
Construction	17	76	76	78	17(s) 1,018(u)	25(s) 2,114(u)	157	2,349	3,524
Total	137	616	616	368	4,925	10,149	737	11,049	16,574
Schedule:[5]									
Start Date	1982	1980	1980	1988	1985	1985	1982	1980	1980
1st Production	1983	1981	1981	1989	1986	1986	1983	1981	1981
Full Production	1984	1986	1986	1990	1994	1994	1984	1986	1986

Source: ERT Project Team

[1] Millions tons per year.
[2] Surface mining.
[3] Underground mining.
[4] Employment figures are based on the assumptions that 75 tons of coal are produced per manshift in surface mining and 15 tons are produced per manshift in underground mining. It was also assumed that ratios of construction employees to operations employees were .14 to 1.0 and .27 to 1.0 for surface and underground mining, respectively.

89i, 98, 136a and b, and 389). Coal transportation directions and destinations are outlined below.

Geographical Coal Lease Areas	Possible Corridor Directions Railroads and Coal Slurry Pipelines
Alton	northwest, west, south
North Kaiparowits	north, south, west, northwest
South Kaiparowits	north, south, west, northwest

Possible Corridor Direction	Railroad Destination
North (C9)	Denver & Rio Grande Western RR spurline at Salina, Utah
Northwest (C4)	Union Pacific RR mainline at Milford, Utah
West (C1)	Union Pacific RR spurline at Cedar City, Utah
South (C18)	Santa Fe RR mainline at Flagstaff, Arizona

Specific destinations for coal slurry pipelines have not been identified, but these could include railheads and proposed power plants.

TABLE 2-3
COAL TRANSPORTATION EMPLOYMENT ASSUMPTIONS FOR POPULATION PROJECTIONS

Employment	Slurry Pipeline	Truck Haul	Rail Haul
Operation	5.5 employees/ million tons coal shipped/year	1.3 employees/ 25-ton truck on road	No significant change in employment
Construction Employment by Route	Alton to Hurricane Cliffs/ St. George area[1] 245 based in St. George and 455 in Kanab for 3 years		S. Kaiparowits to Cedar City 1,100 for 4 years 25% based in Hurricane, 25% in Fredonia (Kanab) 25% Glen Canyon City, and 25% transient along route
	N. Kaiparowits to Koosharem area[2] 390 based in Greenwich/ Koosharem and 390 in Escalante for 3 years		S. Kaiparowits to Milford 1,045 for 4 years 25% based in Beaver, 2525% in Alton, 25% in Glen Canyon City, and 25% transient along route
			S. Kaiparowits to Page 825 for 2 years 75% based in Glen Canyon City 25% transient along route
			N. Kaiparowits to Marysville 990 for 2 years 37% based in Antimony, 37% in Escalante, and 26% transient along route

Source: ERT Project Team

[1] Medium and high production levels
[2] Medium production level

Truck Haul Routes and Approximate Haul Distances on Existing Highway System

Alton to
- Cedar City (via Highway 14) - 66 miles
- Milford (via Highway 20) - 128 miles
- Salina (via Highway 89) - 148 miles
- Navajo Power Plant (east of Page, Arizona) - 88 miles
- Warner Valley Power Plant (south of Hurricane, Utah) - 98 miles

North Kaiparowits to
- Milford (via Highways 12, 89, and 20) - 144 miles
- Salina (via Highways 12 and 89) - 164 miles

South Kaiparowits to
- Cedar City (via Highway 14) - 138 miles
- Flagstaff (via Highway 89) - 158 miles
- Navajo Power Plant - 24 miles
- Warner Valley Power Plant - 130 miles

In order to insure comprehensive analysis, the Steering Committee decided to add the Navajo Power Plant (located 5 miles east of Page, Arizona) and the proposed Warner Valley Power Plant (located 11 miles south of Hurricane, Utah) to the scenarios as possible destinations for the truck haulage of coal during the low production level.

It should be noted that all transportation corridors are being considered for both railroads and coal slurry pipelines except corridor segments C2, C6, C8, and C12 which are being considered for slurry pipelines only (see Map 2-1). This is due to either topographic constraints or the absence of an existing railhead. Since the coal truck haul routes utilize the existing highway system, they are being considered separately from the transportation corridors.

TABLE 2-4
SUMMARY OF COAL PRODUCTION LEVELS

Geographic Coal Lease Group	Coal Production Levels (In Million Tons Per Year) Low	Medium	High
Alton	1-3	8-10	8-10
North Kaiparowits	1-2	15-20	35-40
South Kaiparowits	1-2	30-35	45-50
TOTALS	3-7	53-65	88-100

Rationale for the Selection of Transportation Corridors

The major objective in the selection of the coal transportation corridors was to identify areas where it would be possible to construct and operate future coal transportation systems within the restrictions of general environmental and engineering constraints. Corridor segments were required to contain at least one potential route for a railroad or coal slurry pipeline; however, specific routes were not identified. By selecting corridors between 2 and 15 miles in width, the maximum flexibility for the future location of specific routes was retained. It can be noted elsewhere in this report that there are areas located within the transportation corridors which are poorly suited for the location of a coal transportation system. In most cases, the width of the corridor would allow a system to be routed around such features and thus minimize impacts.

The process of identifying the transportation corridors relied heavily on constraint mapping. Each resource specialist was requested to plot constraints for his discipline on a map of the study area. Constraints were defined as features which would preclude the location of a 10- or 15-mile wide transportation planning corridor. Under this definition, a National Park was a constraint while a National Forest campground was not. If a campground occurred within a corridor segment, it could be avoided during route selection while a large feature could completely block a corridor. Areas which would be suitable for the location of a transportation system (such as existing rights-of-way) were also plotted on a map. Information provided by railroad companies and coal lease holders was very important in identifying engineering constraints for facility location. The corridor boundaries were drawn to include the current routing plans of these companies.

A list of the potential constraints and existing and potential rights-of-way information which were investigated is presented below.

Constraints

- National parks (Map 3-8)
- State parks (Map 3-8)
- Instant wilderness study areas/primitive areas (Map 3-8)
- Indian reservations (Map 3-9)
- Large lakes or reservoirs (Map 3-3)
- Cities (Map 3-9)
- Areas of high archaeological site density (Map 3-6)
- Indian sacred areas Threatened & Endangered species critical habitat (Maps 3-3, 4, and 5)
- Big game critical winter range (Map 3-5)
- Floodplains and wetlands (Map 3-4)
- Prime farm lands (Map 3-9)
- Unstable soils (Map 3-2)
- High seismic activity areas
- Areas of severe topography (Map 2-1)

Rights-of-way

- State highway trucking routes (Maps 2-1 and 3-11)
- Existing high voltage transmission lines (Map 3-9)
- Potential railroad and coal slurry pipeline routes

Once all pertinent information was collected, a composite constraint map was prepared and corridor segements avoiding these constraints were delineated. The relationship of the corridors to major constraints can be seen on the resource maps in Chapter 3. In order to avoid extremely narrow or multiple corridors, certain constraints were allowed to occupy the center of certain corridor segments. Examples are Otter Creek State Park in segment C12 and "The Blues" (see Figure 4-1) and Canaan Peak in segment C13. These areas would be avoided by any future transportation facilities.

The coal truck haul routes were selected to minimize the haul distances from the coal production areas to the destinations and to maximize the use of paved roadways. Destinations which were more than 180 miles from production areas were eliminated from consideration. In most cases, alternate haul routes are not available. Those which are available are longer and/or traverse more miles of unpaved roads than the routes which were selected for analysis in this study.

TABLE 2-5
RATIONALE FOR COAL PRODUCTION LEVELS

Low Level		
Alton	2MTY	Practical level for truck haulage
North Kaiparowits	1MTY	Limited to minimum production due to truck haul difficulties to railheads.
South Kaiparowits	2MTY	Level needed to construct a new haul road off the Kaiparowits Plateau.
Medium Level		
Alton	9MTY	Production level which could be sustained by existing coal reserves (also close to 1/40 diligent development requirements)
North Kaiparowits	15MTY	Minimum level needed to meet 1% diligent development requirements
South Kaiparowits	30MTY	Level needed to amortize a railroad
High Level		
Alton	9MTY	Limit of reserves as above
North Kaiparowits	30MTY	Level needed to amortize railroad (minimum level needed to meet 1/40 diligent development requirements would be about 37MTY)
South Kaiparowits	45MTY	Minimum level needed to meet 1/40 diligent development requirements

Source: ERT Project Team

DESCRIPTION OF POSSIBLE CONSTRUCTION AND OPERATION ACTIVITIES

Coal Production

The following text describes the general steps which would be involved in the development of coal reserves in the Alton and Kaiparowits lease areas. It is not intended to be a detailed description of future mining, but rather a general overview to give the reader an idea of the sources of potential impacts associated with coal development. The text was adapted from the Federal Coal Management Program ES (BLM 1978) and U.S. Fish and Wildlife Service (USDI 1977) publications on surface mining.

Actual development cannot begin until all necessary arrangements have been made with Federal, state, and local governments as well as any private owners that may be involved. Such arrangements include obtaining leases; preparing an environmental impact statement; providing access to the mine property for roadways, railroads, pipelines, and utilities; and obtaining the permits and licenses required by Federal, state, and local authorities. It is required that a mining and reclamation plan be approved before a permit is granted. Bond is posted to insure payment of rents, royalties, and land reclamation costs as mining progresses. Planning would specify how the development work is to be accomplished, the method and equipment to be used for mining, the design of above-ground facilities, the plan for prevention of air and water pollution, and the provisions for reclaiming disturbed land.

After planning, the development of a mine includes construction of roads, utility line tie-ins, and the mine plant. The mine plant would consist of coal-handling and storage facilities, offices, shops and laboratories, equipment storage buildings, and waste disposal areas. A coal washing plant could be constructed as part of the mine plant. Crushing and cleaning of mine-run coal is commonly referred to as beneficiation or preparation.

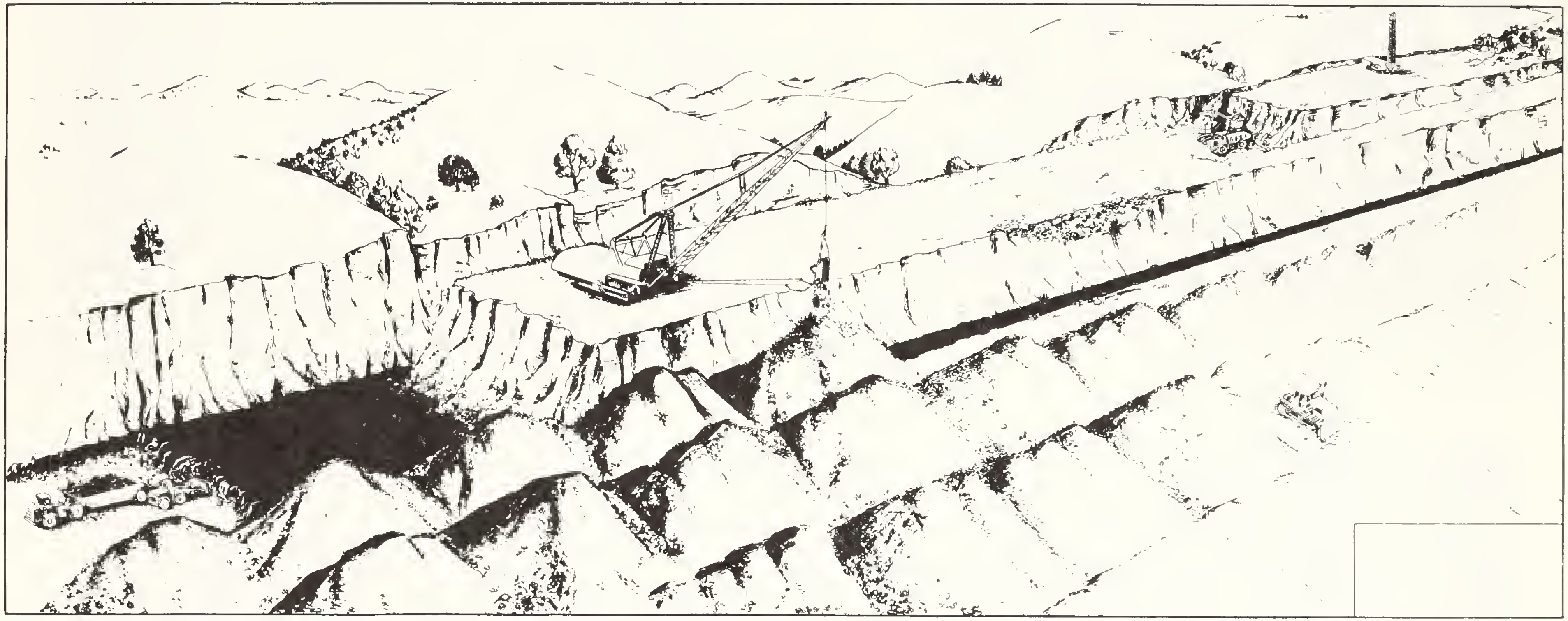


Figure 2-1. Proposed Mining Operations at the Alton Coal Lease Area

Source: Environmental Assessment, Allen-Warner Valley Energy System, Volume V — Alton Coal Field. September 1975.

Whether the coal to be supplied a given customer would undergo preparation processing at the mine plant would depend upon the customer's needs.

Surface Mining

Where coal beds are relatively flat lying and near the surface, as in much of the western United States, stripping is the dominant mining technique. In strip mining, overlying material is removed from a seam of coal in long narrow parallel bands, or strips, followed by removal of the exposed coal. These parallel cuts continue across the coal seam until the thickness of the overburden becomes too great to be removed economically or until the end of the coal seam or property is reached. Both single and multiple seams near the surface can be mined in this manner. Figure 2-1 illustrates the proposed mining operation at the Alton Coal field. The steps involved are described in the following text.

- *Topsoil removal:* Topsoil is removed from areas before mining by large bulldozers or scrapers and is stockpiled.
- *Overburden drilling:* Blast holes are drilled with rotary drills through the overburden materials to the surface of the coal, loaded with high explosives (typically ANFO, ammonium nitrate -fuel oil), and then blasted.
- *Overburden stripping:* The type of equipment used for overburden removal would depend directly on the thickness of the overburden. Where the coal seam is less than 50 feet deep, stripping shovels would be used, while deeper coal seams would require the use of a dragline to strip the overburden. Stripping would start by cutting a trench or box-cut through the overburden down to the coal seam with the dragline operating above the highwall and the shovel operating below the highwall (Figure 2-1). Spoil from this first cut would be placed on adjacent land that would not be mined. When the first strip has been excavated, the machine would turn around and cut a second strip parallel to the first but in the opposite direction. Overburden from each successive strip would be placed in the previous cut that has had the coal removed from it. The final cut would leave an open trench bounded by the final spoil pile and the highwall.
- *Coal drilling and blasting:* Exposed coal would be drilled and then blasted with ANFO.
- *Coal loading and hauling:* Coal would be loaded and transported to the processing plant over special haul roads. Loading equipment would be shovels or front-end loaders, and transport vehicles would be large bottom dump trucks.
- *Crushing, storage, and loading:* The haul trucks would deposit their loads at the processing facility where the coal would be crushed and stored.
- *Grading:* As soon as possible, overburden would be shaped to the desired final topography by bulldozers and scrapers.
- *Reclamation:* Following grading, reclamation and revegetation activities would be started. This would stabilize the area and limit soil erosion.

Underground Mining

Access to coal deposits at an underground operation is provided by either drifts (horizontal entry), slopes (entry less than 30 degrees), or shafts (vertical entry). The coal bed is developed for further operations by driving entries. Although terminology varies, the following system of entries is universal in the industry. Main entries are extensions of the access openings and often run several miles in one direction. Three or more parallel entries, 12 to 22 feet wide and 40 to 100 feet between centers, are driven in a given direction and connected at intervals by crosscuts to provide proper air circulation. These are the major routes of underground transport and access and serve for the life of the mine. Panel entries are driven from the main entries, resulting in a subdivision of the coal bed into blocks or panels having dimensions that may be as much as 1 by 1/2 mile. Panel entries serve as routes from main entries to the working places and for air circulation. Although coal is removed during the driving of both the main and panel entries, it is with completion of the panel entries that the production cycle begins.

Contemporary longwall mining, the method assumed to be used in the Kaiparowits region, was first introduced to the United States in the 1950s, but has long been practiced in European mines. Longwall mining starts with sets of entries cut into the panel areas. The difference in the technique lies in the distance

between these sets of entries and the method used to extract intervening coal. Longwall blocks range from 300 to 600 feet wide and are sometimes a mile long. The longwall machine laterally shears or plows coals from the entire face, transports the fallen coal by an advancing conveyor to a secondary haulage conveyor, reverses direction at the end of a cut, and supports the roof in the area of the face by a self-advancing system of hydraulic jacks. To support the roof at the face, longwall mining originally used manually operated props, then gradually evolved to the presently used powered, self-advancing supports. The longwall mining machine is usually unmanned. The roof is allowed to cave-in behind the advancing work areas; the roof is occasionally blasted to ensure a controlled cave-in rate and to reduce overburden pressure on the coal bed being mined. This controlled cave-in can cause subsidence at the surface.

Longwall mining is used most efficiently in uniform coal seams of medium height (42 to 60 inches) Coal recovery can be close to 100 percent for a given seam, but overall recovery for the study area would be lower. Waste materials are already in underground storage when mining is complete instead of on the surface.

Reclamation

The term reclamation is used here to mean any process for rehabilitating land disturbed by coal mining. Reclamation consists basically of making a mine site safe, acceptable in appearance, and available for other uses before mine abandonment. The goal of reclamation would be to return the land to its former level of diversity and productivity. The dominant surface uses of Federal land in the Alton and Kaiparowits lease areas are for livestock forage production, wildlife habitat, watersheds, and wide-ranging recreational activities.

Reclamation consists of four phases: planning, topsoil/overburden segregation, backfilling, and revegetation. The planning phase begins prior to mining and continues throughout the mining cycle. This phase mainly involves: (1) site mapping, (2) identification of the probable effects of mining before mining begins, (3) development of the reclamation plan, including mitigating measures to be followed during all mining activies, (4) preparation of periodic environmental reports, (5) bond and permit fee-related activities, (6) supervision of the reclamation work, (7) engineering and surveying for environmental protection, (8) water quality monitoring, (9) dust control, and (10) consultation with outside experts.

Topsoil/overburden segregation and backfilling usually include: (1) removal of vegetative cover when its removal is necessary for topsoil salvage, (2) removing and stockpiling toposil and overburden separately, (3) backfilling and grading cuts with original overburden, and (4) replacing topsoil.

The revegetation phase usually consists of the following: (1) soil preparation (discing and/or harrowing, fertilizing, etc.), (2) seeding and/or planting, (3) mulching, (4) irrigation, and (5) maintenance. The methods used in each of the four categories could differ substantially in the three coal lease areas due to different topsoil characteristics and environmental conditions.

Truck Haulage

Transportation of coal by truck is used mainly for initial shipment from the mine to a railhead and for short haul transport to a final destination such as a power plant. Trucks are utilized to a very limited extent for long-haul coal transportation because of high units costs compared to railroads and slurry pipelines. In western states where existing rail services are sparse and capital costs of alternative transportation systems high, coal is frequently trucked longer distances of 100 miles or more. Construction of rail spurs and slurry pipelines can be financially justified only from high volume, long-term production fields. The major advantages of truck haulage of coal is the relatively low capital investment for trucks and their greater flexibility with respect to destination routing through use of the existing highway network.

Most of the coal-hauling trucks on the highways are in the range of 20 to 30-ton capacity, generally require a 35 to 40-ton gross vehicle weight (GVW) truck frame, and are similar to many tractor/trailer trucks currently in use on public highways. A truck this size will have a fuel consumption of approximately 5 miles per gallon, depending upon the vertical grade profile of the highway. The trucks are 2-wheel drive and can traverse grades as high as 10 to 11 percent. Loaded coal truck operations are limited by vehicle speed and maneuverability. On long steep vertical grades, the operating speeds of the loaded coal trucks can be reduced significantly below speeds for automobiles. Similarly, operation of coal trucks on narrow roadway segments or areas of excessive horizontal curvature such as a series of switchbacks can be difficult due to

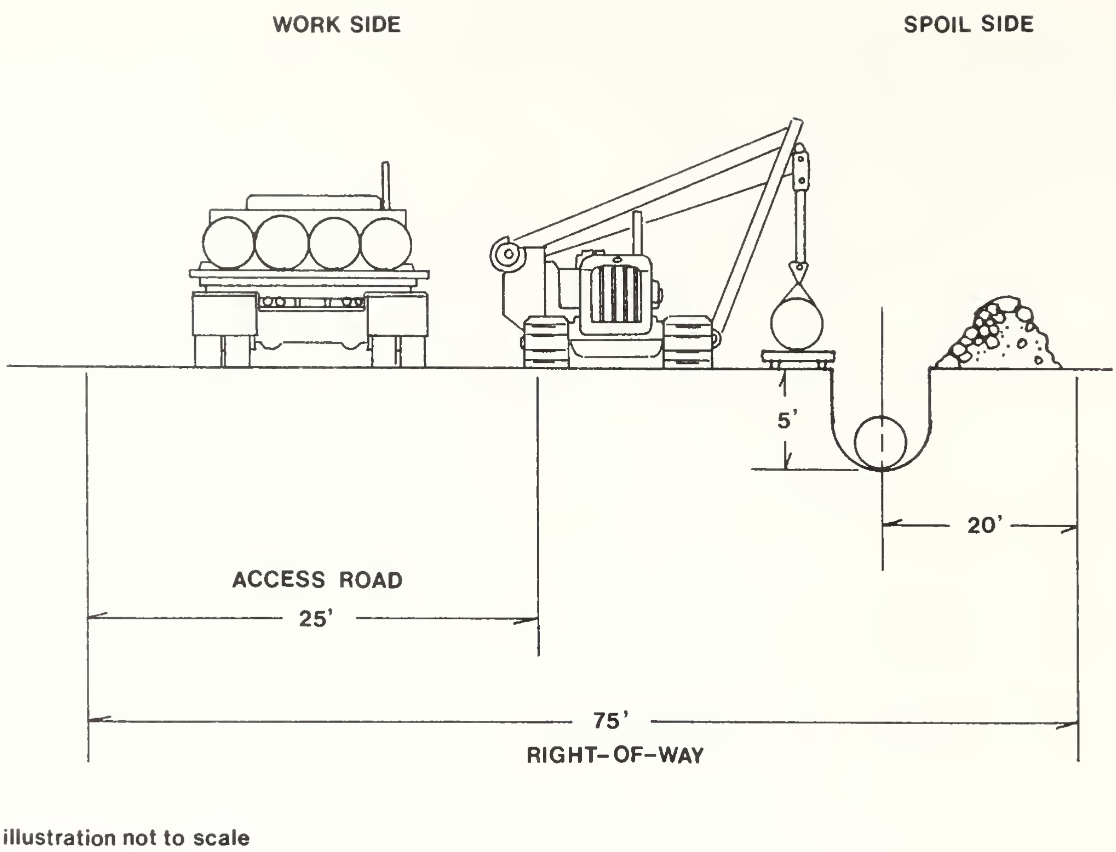


Figure 2-2. Cross-section View of Typical Coal Slurry Pipeline Construction.

the restricted lateral clearance between opposing traffic flow and obstructions along the roadway edge.

Given the 40-ton GVW of loaded coal trucks, the weight capacities of roadway crossing culverts and iron grate bridges on many gravel county roads can be an operating constraint. Depending upon the stability of the roadway sub-base and pavement for unpaved and paved roads, the repeated axle loadings of coal trucks can accelerate the deterioration of the roadway surface, especially during wet conditions. This can impose an additional operating constraint.

Slurry Pipelines

The use of slurry pipelines for the transportation of coal is still in its infancy, although the technology is well developed. Only one such pipeline system, the Black Mesa slurry line in Arizona with annual through-put of 4.8 million tons, is currently operational. Additional pipeline systems are in the process of being developed to provide transportation capacity of about 140 million tons per year. Due to the time required to plan, construct, and make coal slurry pipelines operational, and to resolve the issues surrounding the development of this industry, no significant coal pipeline transportation capacity is contemplated through 1990.

Coal slurry is pulverized coal mixed with water in nearly equal amounts by weight. A coal slurry pipeline is a system of pipes which transports coal in the form of a slurry from a mine to a power plant or other destination. The major components of a slurry pipeline operation are the slurry preparation plant, the pipeline, the pumping stations, the water and slurry storage ponds, and the slurry dewatering plant. An approximate right-of-way width of 75 feet (9 acres/mile) would be required for coal slurry pipelines which might service the Kaiparowits region. Maximum grade would be approximately 16 percent. Pumping stations, each with an emergency storage pond covering about 50 acres, would generally be located every 60 to 100 miles along the line. The entire pipeline would be underground, including

crossings of most rivers and streams. Construction of a typical pipeline is illustrated in Figure 2-2. Once in place, the coal slurry pipeline is not subject to stoppages due to weather or labor problems. The pipeline is odorless, noiseless, dustless, and hidden from sight.

Water requirements for coal slurry transport can be estimated by assuming that 50 percent (by weight) of the slurry is water. Transport of 9 million tons of coal per year from the Alton coal field would require approximately 6.3 million gallons of water per day (gpd), while a slurry pipeline to transport 15 MTY of coal from the North Kaiparowits lease area would require approximately 10.6 million gpd. The precise amount of water required would vary with the length and diameter of the pipeline. Water is removed from the slurry by either centrifugal force or filtration. The coal is then dried and used by the power plant. The separated water may be used in many ways. These include use for water makeup, cooling towers, or potentially, reuse in slurry.

The reuse of water in recycle lines has been suggested as a possible means of cutting water extraction from the arid western states. In this type of parallel pipeline system, the only water required for the slurry system would be that which would be lost as surface moisture on the dewatered coal cake, storage pond evaporation, and minor system utility demands. These requirements would amount to about 1,000 to 2,000 acre- feet per year. Suggestions have also been made to use a parallel pipeline where the ultimate user of the coal supplies the water.

Rail Haulage

Approximately two-thirds of the coal produced in the United States is transported by railroad. The "unit train" is a particular type of rail service used by major shippers of coal to take advantage of economics of scale. Unit trains carry only coal in dedicated service between two points in sufficient volume to achieve cost savings. Coal unit trains operating in the western states tend to use 100-ton hopper cars designed for automatic loading and unloading. Unit train operations are designed to minimize switching and time-consuming delays in freight yards.

FIGURE 2-3. Typical Coal Unit Train

Photo Courtesy of Santa Fe Railway

Operationally, the loaded unit train moves directly from the mine to the delivery point, stopping only for necessary crew changes, inspections, and servicing. Unloaded trains return immediately to the mine intact for reloading. In actual operation, unit trains typically experience turn-around times of one-third to one-fifth those of conventional trains. A typical coal unit train consists of six 3,000-horsepower locomotives and 80 to 100 hopper cars with carrying capacities of 100 tons each (see Figure 2-3). The size of the hopper cars that can be accommodated depends upon roadbed conditions and the weight the track can tolerate. Speeds vary considerably depending on track conditions and grade, but 20 to 50 miles per hour is a common range. In the Kaiparowits study area, a rail line would require a right- of- way approximately 200 feet in width (24 acres/mile).

During operation of the Kaiparowits fields, coal could be transported up to about 5 miles on enclosed conveyors where it would be deposited for unit train loading (see Figure 2-4). The track configuration at the loading area would depend upon economic and technical factors. In most coal- loading operations, the train would be loaded by moving the hopper cars under a flood feeder at a uniform speed at .5 to 1.25 miles per hour, thus filling the cars while the train is moving.

Due to the heavy loading imposed by unit trains and the frequency of traffic, it is generally accepted by the railroad industry that continuous welded rail be used rather than the conventional jointed rail. The use of thicker ballast sections with wider shoulders along with the continuous welded rail provides a cushioning effect against the dynamic loading imposed by unit trains. Another factor in the construction of unit train rail lines is the requirement for reduced track curvature and gradient because of the length and weight of the trains. In the Kaiparowits study area, vertical grade would be limited to about 1.5 percent. Because of the special needs of the coal unit train, sections of existing rail and roadbeds frequently need improvement prior to use.

FIGURE 2-4. Unit Train Loading

Photo Courtesy of Santa Fe Railway

CHAPTER 3

DESCRIPTION OF AFFECTED ENVIRONMENT

INTRODUCTION

This chapter describes those elements of the existing environment in the Kaiparowits study area that might potentially be affected by the coal production and transportation scenarios presented in Chapter 2. These elements include: climate, air quality, visibility, topography, geology, minerals, soils; water resources, vegetation, wildlife, paleontological resources, archaeological resources, Native American concerns, visual resources, recreation and wilderness resources, land use, transportation, socioeconomics, sociocultural aspects, and noise. Also included in this chapter is the identification of potential Areas of Critical Environmental Concern and a short description of the likely future environment without coal development.

ENVIRONMENTAL ELEMENTS

Climate

The climate of southern Utah is determined by its topography and its location relative to the major sources of atmospheric moisture which are the Pacific Ocean and the Gulf of Mexico. Winter-season Pacific storms reaching Utah must first cross the Sierra Nevada and Cascade Ranges to the west, where orographic lifting of the air masses results in the majority of the moisture condensing and falling out as precipitation. Thus, air masses reaching southern Utah from the west are generally dry and the associated precipitation is light. During the summer, moist air masses move into southern Utah primarily from the Gulf of California. Precipitation from these air masses usually results in thundershowers with maximum activity occurring during late July.

Precipitation does not fall uniformly over the study area. Elevated terrain in the western half of the study area is favored because mechanical lifting of air masses results in higher average precipitation amounts there. For example, approximately 32 inches per year fall annually in the Cedar Breaks area of the Markagunt Plateau, whereas an average of 8 inches per year is reported in the area of Hanksville. The wettest period of the year normally occurs during the winter, with a broad secondary maximum extending through late summer. On the Kaiparowits Plateau, the wettest month is usually March but the moisture deposited is more uniformly spread throughout the year there than in the western part of the study area, where late winter precipitation is favored. About 62 percent of the annual precipitation usually falls during the winter season.

Temperatures in the study area are moderately cold in the winter and hot during the summer. However, average temperatures are highly dependent on elevation. For example, at St. George, where the elevation is 2,750 feet above mean sea level (MSL), the mean January maximum and minimum temperatures are about 54°F and 26°F, respectively. In contrast, mean maximum maximum and minimum temperatures recorded at Escalante (approximately 5,700 feet MSL) in January are about 38°F and 10°F. Summers in southern Utah are generally hot, ranging between 72°F and 100°F for a mean maximum daytime temperature. Table 3-1 displays mean maximum and minimum summer and winter temperatures for seven cities in the study area.

The surface winds in the study area average about 8 miles per hour (mph). Lower windspeeds are associated with stable atmospheric conditions which occur about 40 percent of the annual hours. Higher wind speeds are usually associated with the passage of frontal systems or thunderstorms. These occur intermittantly during the winter and summer months, respectively. During the fall and winter months, stationary high pressure systems tend to settle over the study area, resulting in very light winds at the surface and persisting for several weeks. Because of poor ventilation during these periods, emissions near the surface are not easily transported out of the area. Surface winds are strongly influenced by local topography. During daytime and strong regional wind conditions, surface winds are channeled by valleys and around blocking terrain, decreasing in speed and increasing in turbulence. At night, the upper level winds often become decoupled from the surface winds which flow downhill as air near the ground cools.

TABLE 3-1
MEAN MAXIMUM AND MINIMUM TEMPERATURES IN SOUTHERN UTAH

	January		July	
	Maximum (°F)	Minimum (°F)	Maximum (°F)	Minimum (°F)
Alton	36	13	88	51
Cedar City	40	16	88	57
Escalante	38	10	84	53
Hanksville	40	11	96	60
Kanab	46	20	94	56
Milford	36	12	92	56
St. George	54	26	100	68

Source: Based on data from *Climates of the States* Volume II. 1974. U.S. Department of Commerce, NOAA. Water Information Center, Inc.

Additional information on temperature, precipitation, and wind can be found in the ERT Air Quality Technical Report (1980).

Air Quality

The Kaiparowits study region is primarily a rural area with light industrial activity. Therefore, the existing air quality of the region is excellent. With the exception of sulfur dioxide (SO2) all other parameters are within the allowable State and Federal air quality standards (refer to Appendix A, Tables A-1 and A-2 for air quality standards).

The Utah State Division of Health has operated four monitoring sites in southern Utah for two or more years each during the past decade. In addition, air quality monitoring has been conducted for several years in Page, Arizona by both the Arizona State Department of Health Services and Salt River Project, an Arizona utility. The long- term records have been supplemented by limited monitoring programs performed in the area, especially those done for potential and existing power plant sites. Table A-3 Appendix A lists the location, period of record, and pollutants monitored for each state-run and supplementary monitoring station.

The available data from the monitoring programs are presented by pollutant in the following sectins. Primary, secondary, maximum, and annual mean concentrations are given, where available, for each pollutant measured at each station. Detailed information on the monitoring results can be found in Appendix A or the ERT Air Quality Technical Report (1980).

Total Suspended Particulates (TSP)

Annual geometric mean and maximum 24-hour average TSP concentrations at each of the six long-term or primary monitoring sites in the region are shown in Appendix A (Table A-4). Except for Cedar City and Page, annual means are low, 11 to 28 micrograms per cubic meter($\mu g/m^3$), reflecting the rural nature of the study area. Isolated high daily values, however, were recorded at most of the monitors. This pattern typifies rural TSP levels where wind- blown soil is the major contributing source of particulates. Days with very high winds produce dust storm conditions which can have a significant short-term effect on visibility.

The number of days on which the primary and secondary 24- hour National Ambient Air Quality Standards (NAAQS) for TSP were violated at each long-term site are shown in Appendix A (Table A-5). A great deal of year-to-year variation is evident in the number of violations of the short-term particulate standards. However, the range of violations per year was between 1 and 5 days. This is due to natural variations in windy conditions across the study area.

Sulfur Dioxide (SO_2)

The observed SO_2 concentrations monitored at the six long-term stations in the study area are presented in Appendix A (Table A-6). Because the area lacks large industrial sources, concentrations are very low at all stations except at Cedar City which is the industrial center of southern Utah. Annual arithmetic means for Cedar City ranged from 43 to 86 $\mu g/m^3$. The short-term SO2 standards were exceeded during each monitored year at the Cedar City station. The number of violations ranged from 1 to 7 (Appendix A, Table A-7) resulting from local industrial activity.

Nitrogen Dioxide (NO_2)

Relatively little NO_2 monitoring has been done in southern Utah since there are no major urban areas and few major combustion sources. Maximum and mean NO_2 concentrations measured at four of the primary sites are shown in Appendix A (Table A-8). The only averaging time for which an air quality standard exists is the annual mean; the NAAQS and Arizona NO_2 standard are both 100 $\mu g/m^3$ for an annual arithmetic mean. Observed annual means in southern Utah are well below these standards.

Oxidant (O_3)

Monitoring data for oxidant (O_3) are available from only two sites in the study region (Page, Arizona, and the Fremont River site in Wayne County, Utah). Maximum hourly concentrations measured at each site are presented in Appendix A (Table A-9). The regional oxidant levels are below the ambient standard of 160 $\mu g/m^3$ for Arizona and the current NAAQS of 235 $\mu g/m^3$ for oxidant as ozone. Although oxidant is primarily an urban pollutant, significant levels such as those observed in the study region can occur in rural areas.

Carbon Monoxide (CO)

No data on CO levels are available for the southern Utah study area. However, the primarily rural character of the area and the absence of large numbers of automobiles leads to the conclusion that CO levels are low. Monitoring performed in other rural or suburban parts of Utah and Arizona has shown maximum 8-hour averages of 5 mg/m^3 or less (AeroVironment 1977), well below the standard of 10 mg/m^3.

Hydrocarbons

No monitoring of hydrocarbons (HC) has been conducted in the southern Utah study area. The relatively small automobile population and lack of industry suggests that regional HC concentrations are low.

Lead

The only location in the study area where atmospheric lead concentrations have been regularly monitored is Page, Arizona. The Arizona Department of Health Services analyzes the filters from their high volume (HIVOL) sampler located at the Page Airport for several particulate constituents including lead. The maximum quarterly averages for Page, Arizona, are presented in Appendix A (Table A-10). Due to the lack of significant industrial sources of lead in the area, it is reasonable to assume that these low levels of lead particulates extend region-wide.

Visibility

In an operational sense, visibility is used to mean visual range or how far a large dark object may be seen. In this study, visibility is of aesthetic interest and encompasses not only visual range, but also contrast and color quality.

When looking at a distant object through the natural atmosphere, the observer notices that the object or its details (texture) may be obscured by a haze and have its colors changed. The haze itself may appear a different brightness and may be colored. Since brightness and color are contents of consciousness, they cannot be measured by instruments. The physical antecedents of brightness and color are the amount of light energy entering the eye and its distribution among visible wavelengths. These parameters have been measured with multiwavelength telephotometers along several vistas in the study area in studies sponsored by the National Park Service, beginning in 1979. Airport visual range statistics and measurements from other areas are available and are related to telephotometer data in the Air Quality Technical Report.

Particle scattering is the major physical cause of visibility degradation in the study area. Small particles, in the size range of bacteria (0.1 to 1.0 μm diameter), are by far the most efficient in scattering light on a per unit mass basis. Unfortunately, these particles are in the size range that remain suspended in the atmosphere for the greatest time. In the study area, fine particulates formed from road dust, agricultural dust, and wildfire smoke, as well as engine emissions and cloud droplets occasionally limit visibility by such scattering. Some particulates (SMOG) result from atmospheric reactions of gaseous pollution such as SO_2, NO_x, and hydrocarbons.

The only ambient gas able to affect visible light is nitrogen dioxide, which is a combustion product found in power plant plumes and vehicle exhaust. In high concentrations, it will make white light look red-brown. Detailed current emission inventories for all pollutants in the study area are found in the Air Quality Technical Appendix.

Visibility parameters may vary widely from day to day with changes in weather and

TABLE 3-2
EXISTING VISIBILITY
(Geometric Mean Standard Visual Range Computed from Actual Data) Summer and Fall 1979
(kilometers)

Vista	Cloud Free Sun-Target-Observer Plane AM	Noon	PM	All	Clouds Present AM	Noon	PM	All
Lava Point to Bryce Canyon	222	244	273	242	209	209	224	214
Lava Point to Mt. Trumbull	199	199	238	206	204	195	215	204
Bryce Canyon to Navajo Mountain	219	---	240	230	218	---	222	220
Bryce Canyon to Mt. Trumbull	1239	---	233	237	230	---	221	226

Source: ERT Project Team

events upwind of the study area. High winds may entrain soil dust and significantly impair visibility, and although most of these particles are large and settle out rapidly, about 1/3 of road dust particles are small, efficient light scatterers. Wood fire smoke or combustion exhaust can produce significant visibility reductions even at large distances from the source. Regional and continental scale winds may carry urban plumes into the study area especially during the late summer. Cloud droplets themselves interfere with visibility not only by direct scattering, but by contrast reduction by cloud shadows. Also high humidity conditions will encourage the growth of very small particles into a size range which is the most efficient in scattering light. In the study area, summer season synoptic weather patterns are the controlling factor in the occurrence of water hazes and high humidity.

Man's activities in the local area provide a constant, ever-growing source of emissions with the major sources of visibility-reducing partic ulates combustion sources such as coal fly ash or diesel exhaust particulates. Combustion sources also emit reactive gases that convert to particulates in the atmosphere. Finally, any high temperature combustion using air will produce some nitrogen oxides with a certain portion being or becoming nitrogen dioxide. Light scattering, and therefore visibility, is greatly affected by the relative geometry of the haze, sun, and observer.

Geometric mean standard visual range is reported for several vistas in the study area by time of day in Table 3-2. These data are based on telephotometer measurements. The vistas which are reported in Table 3-2 are a subset of the seven vistas which were evaluated as part of the visibility impact analysis. These included four vistas from Bryce Canyon, two vistas from Zion, and one vista from Grand Canyon National Parks (Figure 3-1). Experience has shown that this definition of visual range overstates the actual distance which natural objects can be seen. As a rule-of-thumb, one may expect to be able to observe natural objectives out to about 75 percent of the standard visual range. (Snow-covered mountains are visible for longer distances because of their larger contrast). In the study area, the geometric mean standard visual range is about 200 kilometers (124 miles); thus, targets up to 150 kilometers (93 miles) should be typically observed. In fact, Navajo Mountain and Mount Trumbull are normally observed at ranges of 130 to 140 kilometers (81 to 87 miles) in this area.

Most natural and pollution hazes do not alter the color of objects on the horizon, except to add white light. This produces "washed out" colors at a distance. In the west, distant objectives take on a bluish tint due to the preferential scattering of blue light into the sight path by the gases in the atmosphere. In southern Utah, the colors of the rock strata are a very important part of the visual experience of the landscape.

Topography, Geology, and Minerals

The coal lease areas and transportation corridors are primarily in the Colorado Plateau Province with the ends of the northward and northwestward- trending corridors in the Basin and Range Province (Fenneman 1931). The principal topographic features of the coal lease areas are high plateaus cut locally by deep canyons which often form major obstacles to travel. Topographic features of the transportation corridors are similar but also include alluvial-filled valleys bordered by mountains. Elevations range from about 3,000 feet above sea level near Warner Valley to more than 10,000 feet near the North Kaiparowits coal lease area. Surface drainage of the Kaiparowits Region is predominantly to the Colorado River system, from Lake Powell

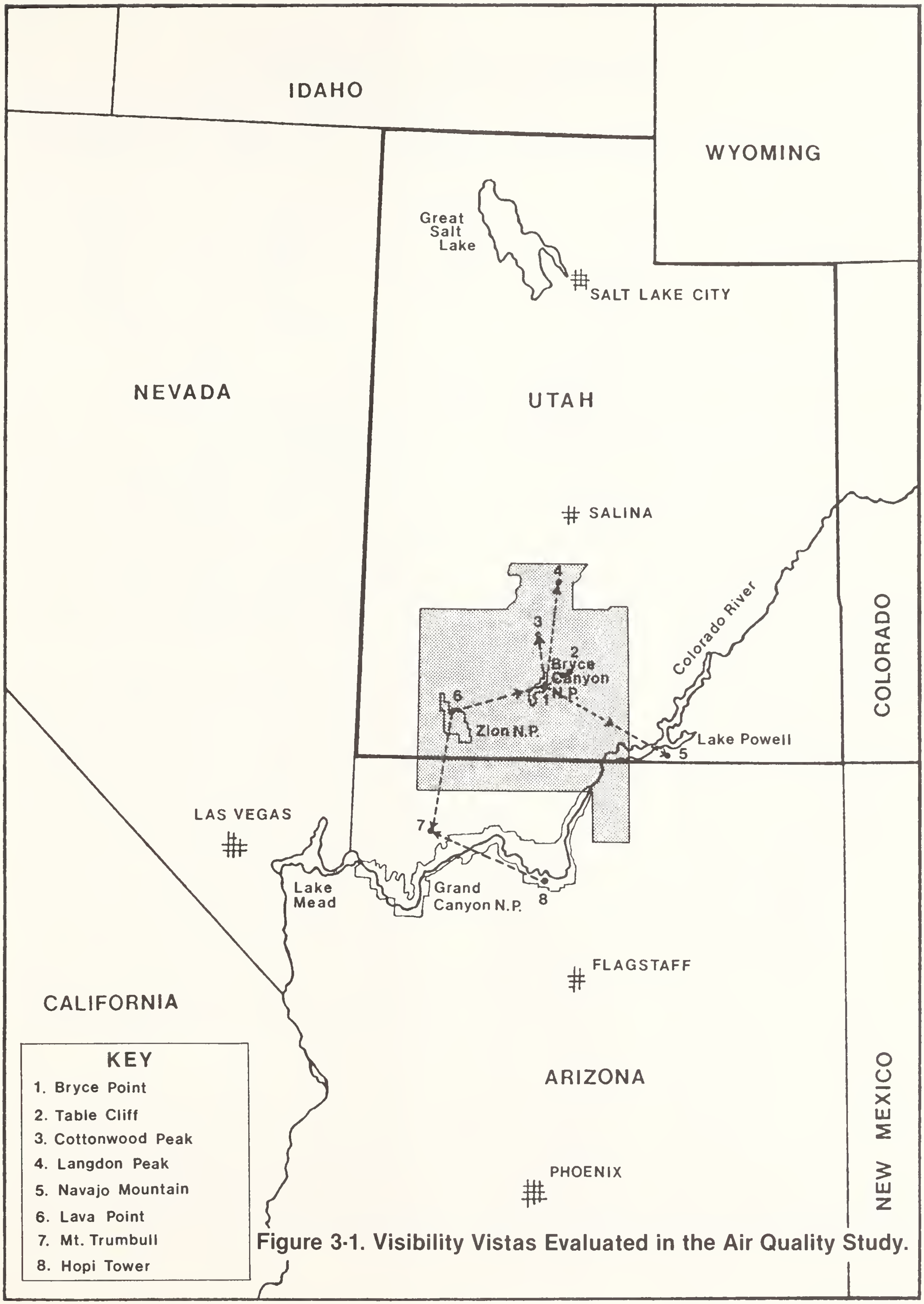


Figure 3-1. Visibility Vistas Evaluated in the Air Quality Study.

TABLE 3-3
SOUTHERN UTAH COAL QUALITY DATA

	Average Percent			
	South Kaiparowits	North Kaiparowits	Alton (West)	Alton (East)
Moisture	9.63	10.51	17.0	19.3
Volatile Matter	42.44	45.39	40.1	43.6
Fixed Carbon	48.70	46.81	50.3	46.7
Ash	8.59	7.80	9.4	9.8
Sulfur	.75	1.26	1.3	1.07
Btu/lb	12,401	11,563	12,069	10,166

Source: Doelling and Graham, 1972.

downstream to Lake Mead below Grand Canyon. Some drainage is north to the Basin and Range Province through the Sevier River system.

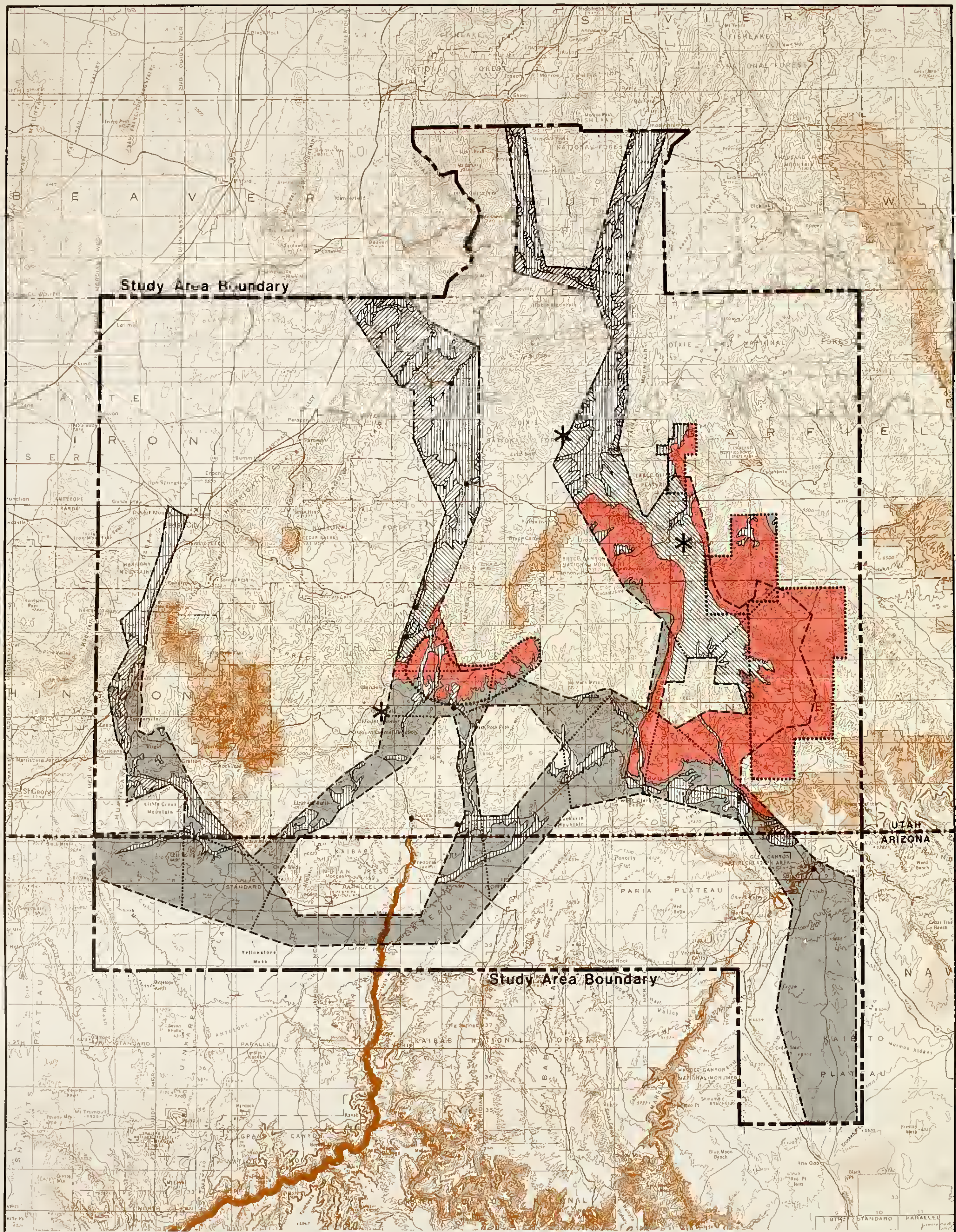
The geology of the region has been summarized by Gregory and Moore (1931), Gregory (1951), Doelling and Graham (1972), and Sargent and Hansen (1976) and is shown on the geologic map of southwestern Utah (Hintze 1963). The geology of the study area (Map 3-1) has been simplified into five map units. These are: (1) Pre-Cretaceous sedimentary rocks of Jurassic, Triassic, and Permian age; (2) Upper Cretaceous coal-bearing rocks; (3) Tertiary and Upper Cretaceous sedimentary rocks; (4) Quaternary and Tertiary volcanic rocks; and (5) Quaternary and Tertiary sedimentary rocks, mostly alluvium. The exposed bedrock in the coal lease areas is of Cretaceous and Jurassic age with a small area of basalt in the Alton area. Corridor segments C9, C12, C13, and large portion of C4 contain mostly alluvium and volcanic rocks. The last 18 miles of corridor segment C1 is also alluvium. Corridor segments C2, C3, and C7 in Arizona are mostly sedimentary rocks of Pre-Cretaceous and Cretaceous age.

The Kaiparowits and Paunsaugunt Plateaus are underlain by geologic formations having gentle dips, generally trending northward, interrupted by monoclines, anticlines, and synclines. In addition, the formations are cut by numerous faults. Two major faults are the Paunsaugunt and Sevier, which trend northward and form the east and west boundaries of the uplifted Paunsaugunt Plateau. The North and South Kaiparowits lease areas are in the Kaiparowits structural basin, which extends from the Utah-Arizona border northward to the mountains west of Escalante, Utah. The structural relief in this basin is about 4,000 feet. The Alton lease area occurs between the Paunsaugunt and Sevier faults in a broad northward-trending syncline.

The Kaiparowits region is part of the intermountain seismic belt, which is a zone of pronounced earthquake activity that extends from Arizona to Montana. Seismic data (Cook and Smith 1967) indicate that Richter magnitudes in the area have not exceeded 4.9 and most are less than 4.0. Relevant data (U.S.D.I. Bureau of Land Management 1976) indicate that earthquakes of low intensity will occur; however, the effects of such earthquakes will be slight.

The Kaiparowits coal field, which includes the North and South Kaiparowits coal lease areas, has been described by Doelling and Graham (1972). Mineable coal beds which contain the best quality coal in the region (Table 3-3) occur in the Straight Cliffs Formation. Total reserves for the coal field, as defined by Doelling and Graham (1972), are estimated to be 15.2 billion short tons (Table 3-4). The amount of reserves for the coal lease areas would be less; however, data were not available to readily determine the amount. The coal occurs as lenticular seams and is confined to several zones, the most important being the Christensen (Henderson), Alvey, and Rees coal zones. These coal beds were deposited during Cretaceous time in a northwest-trending zone 18 to 25 miles wide which paralleled the old shore lines.

The Alton coal field has also been described by Doelling and Graham (1972). Two coal zones, Smirl and Bald Knoll, occur in the Dakota Sandstone. The quality of the coal is given in Table 3-3. Reserves for the field have been determined to be 2.1 billion tons (Table 3-4), of which about 0.2 billion tons occur less than 200 feet from the surface and are stripable.



MAP 3-1. Geological Formations

- Quaternary and Tertiary Sedimentary Rocks
- Quaternary and Tertiary Volcanic Rocks
- Tertiary and Upper Cretaceous Sedimentary Rocks
- Upper Cretaceous Coal-bearing Rocks
- Pre-Cretaceous Rocks (Jurassic, Triassic. & Permian Age)
- * Potential Limestone Quarries

Note: Modified from Hintze (1963) and Wilson et al. (1969).

TABLE 3-4
COAL RESERVES IN THE KAIPAROWITS STUDY AREA
(In Short Tons)

Reserve Classification[1]	Classification Criteria[1]	Alton Coal Field[1]	Kaiparowits Plateau Coal Field[1,2,3]
Measured reserves (Class I)	Based on adequate exploration and development data, properly correlated.	———	———
Indicated reserves (Class II)	Based on geologic measurement supplemented by limited drill hole data and limited to 1½ miles from a control point.	643,800,000[4]	3,984,800,000[4]
Inferred reserves (Class III)	Based on geologic inferrence and projection of the habit of the coal beyond 1 miles from control points.	865,600,000	3,893,200,000
Potential reserves (Class IV)	Based on geographic and geologic position, with little supporting data, and includes coal concealed by 3,000 feet or less of cover.	639,500,000	7,320,000,000
Total		2,148,900,000	15,198,000,000

Source: ERT Project Team
[1] After Doelling and Graham (1972).
[2] Much larger area than North and South Kaiparowits lease areas as defined in this environmental analysis.
[3] U.S. Department of Interior, Geological Survey (1979, Fig. II-6) for Kaiparowits Plateau Coal Field gives a preliminary estimate of 20 billion short tons of coal from coal beds 4 feet or more thick and overburden no thicker than 3,000 feet.
[4] Includes a small amount of Class I reserves.

Other mineral resources have been identified by Doelling (1975), Sargent and Hansen (1976), and U.S. Department of the Interior, Geological Survey (1979). Several test wells for oil and gas have been drilled, and a small oil field was developed in 1964 on the Upper Valley anticline about 10 miles southwest of Escalante. Locally, combustible gases occur in and near some coal beds; however, the concentrations are unknown.

Limestone suitable for rock-dusting in coal mines is available at several places in the Kaiparowits region. According to the U.S. Bureau of Land Management (U.S.D.I., BLM 1976), such limestone occurs in the Wasatch Formation on the west side of Johns Valley in T34S, R3W, in the Canaan Peak area, and in the Carmel Formation east of Orderville, Utah (Map 3-1). Because other outcrops of limestone occur in the Kaiparowits region, more localities having potential as quarries are probably present. Clay, gypsum, sand and gravel, and dimension stone are present throughout the Kaiparowits region.

Soils

The soils of the study area reflect the variability of the soil-forming factors (geology, topography, climate, and vegetation). Generally, the soils have developed from fine-grained igneous materials in the northern part of the study area and sandstones and shales in the southern part, resulting in textures ranging from clayey to sandy. Soils over most of the area receive low amounts of precipitation resulting in limited soil development and productivity potential. Mean annual soil temperature ranges from about 47°F in the mountainous areas to 59°F in the lower valleys. Typically, soils where annual precipitation is under 15 inches exhibit a high soluble salt content, high pH, low organic matter content, and an accumulation of carbonate in the subsoil which may form a hardpan. As elevation and precipitation increase, these characteristics reverse, resulting in better soil development and increased productivity potential.

The soils within the study area are classified into 20 soil groups composed of 34 soil families. The distribution, areal exent, land form description, climate, use, physical and chemical characteristics, and taxonomic classification are outlined in Wilson et al. (1975) for Utah and by U.S. Department of Agriculture, Soil Conservation Service (1975) for Arizona. These soil families are generally representative of the study area, but local variations will occur. Soil characteristics that may be considered significant in this regional planning study are high shrink-swell potential, shallow depth, and high erodibility, all of which may present problems during construction and reclamation activities. Soils suitable for farming are considered a valuable resource in the study area. Soil groups that have the above characteristics are located on Map 3-2. These soil characteristics may not apply to all soils within a group so the mapped areas must be regarded as depicting soil groups with a high liklihood of exhibiting these characteristics.

High shrink-swell hazards are associated with soils which have a high content of expanding clays. These soils may create engineering difficulties due to structural failure caused by ground distortion. Approximately 50 percent of the soils within the coal production and transportation areas have shrink-swell limitations.

Shallow soils present engineering limitations due to difficulty in excavation and revegetation. Excavation activities in these soils may require heavy equipment and blasting. Revegetation success may be affected by inadequate rooting medium and low water-holding capacity. Approximately 65 percent of the study area has shallow soil limitations.

Approximately 40 percent of soils within coal production and transportation areas may exhibit erosion problems. Clayey textured soils are susceptible to water erosion and sandy textured soils are susceptible to wind erosion.

Soils currently now used for farming or which have a high potential for farming are found mainly within the alluvial valleys within the study area. These soils are relatively scarce in the southwest and represent an important resource.

Water Resources

Water Supply

In recent years considerable attention has been given to the evaluation of the water supply of the southern Utah coal areas. The region is one where industrial, agricultural, or resources developments must meet their needs from a dwindling supply of available water. Most of the water resources have been assigned. There are, however, large quantities of water stored within the rocks in the form of groundwater that may be utilized. In addition, some claims on the supply of the Colorado River water from Lake Powell remain to be assigned to the final users.

All waters in Utah are declared to be the property of the public, and therefore, subject to the doctrine of prior appropriation. Utah public policy is that of ensuring the highest possible development and most continuous beneficial use of all available water with as little waste as possible. Waters which have been appropriated and reduced to private control cease to be public water for the period of possession and are not subject to appropriation. These acquired rights may be sold and transferred to another party. Utah water laws do not require the maintenance of a minimum flow in a stream for the preservation of aquatic habitat so a stream may be completely dewatered by a diversion except as dictated by a downstream water right. The State Engineer is the state official who is charged with the administration of waters within the state.

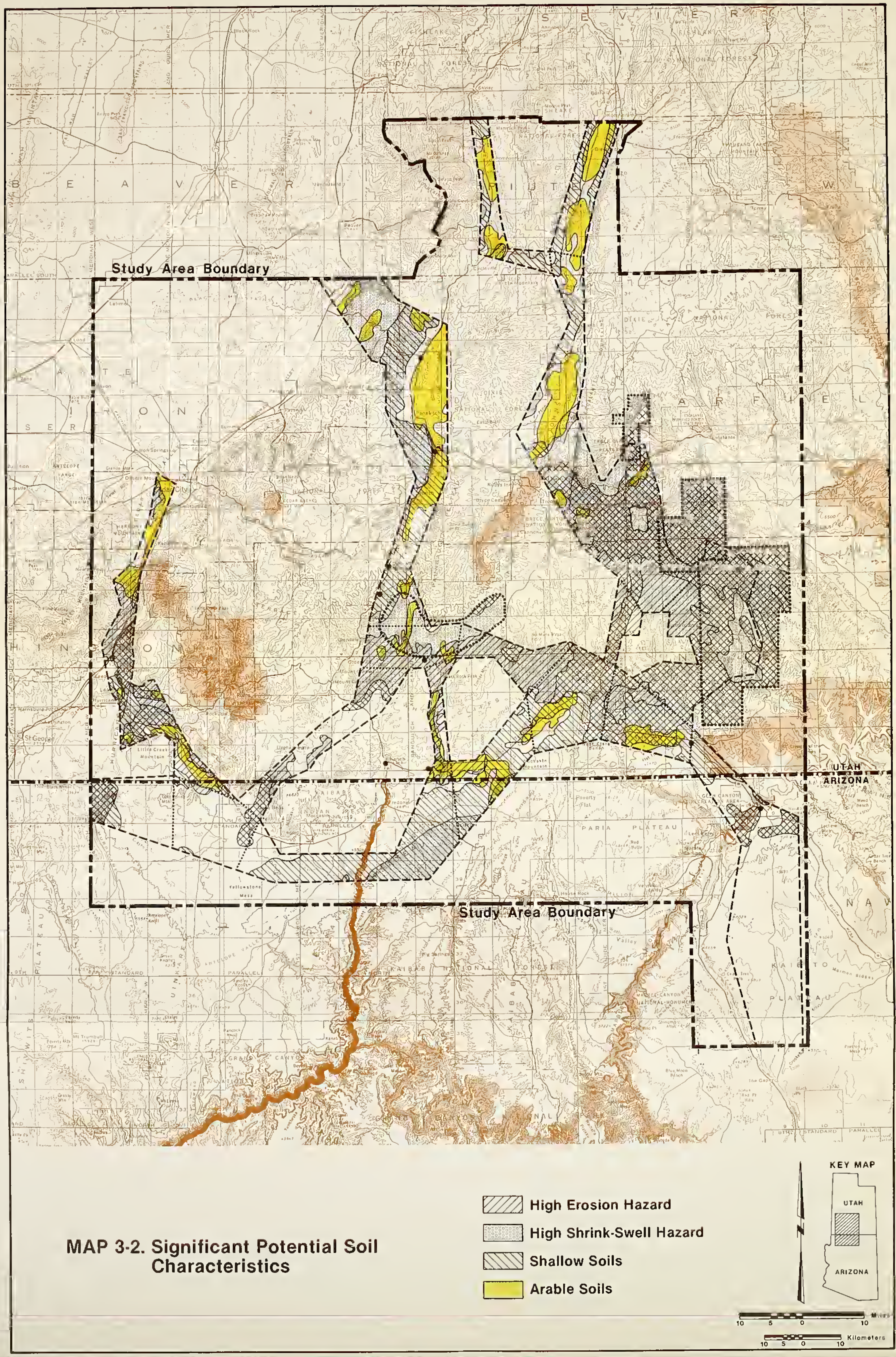
A description of current water use in the region was presented in the Southern Utah Regional EIS and is reproduced here as follows:

"Estimates of the use of water in the study area as follows:

Irrigation	93-96 percent
Municipal and industial	4-6 percent
Managed wetlands	0-5 percent

The quantity of water applied annually to croplands averages 3.6 acre-feet per acre.

Ground water is used to some extent for irrigation, for domestic and stock purposes, and public supply. Although the total amount of ground water used is small, it is the principal source of water for the small communities (total domestic use in the region is about 100 acre-feet per year). Water from both wells and springs is utilized, but springs provide the greater quantity of water. Springs and seeps throughout the area supply water for livestock and wildlife; many have not been mapped, and the number and flow of these springs probably varies with the season and climatic conditions. Some may go dry at times. The total volume of water used is not known, but is presumably small. Nonetheless, these springs and seeps are an important source of water for livestock and wildlife."



MAP 3-2. Significant Potential Soil Characteristics

TABLE 3-5

PEAK FLOWS EXPECTED FOR 50-YEAR AND 100-YEAR FLOODS FOR VARIOUS SUB-BASINS

Area	50-yrs. (cfs)	100-yrs. (cfs)	Area	50-yrs. (cfs)	100-yrs. (cfs)
1	1,098	1,629	13	998	1,485
2	2,184	3,195	14	2,238	3,298
3	1,778	2,638	15	456	710
4	2,105	3,121	16	2,329	3,453
5	2,555	3,774	17	7,878	11,548
6	1,780	2,673	18	7,912	11,669
7	785	1,184	19	10,084	15,018
8	1,270	1,940	20	4,299	6,385
9	2,037	3,075	21	3,125	4,635
10	2,113	3,205	22	1,791	2,630
11	3,003	4,343	23	5,756	8,478
12	7,647	11,402			

Navajo Sandstone groundwater is not used at this time because of the extremely high cost involved to drill and pump water from that depth.

The Upper Colorado River Basin Compact of 1948 limits Utah's allotment of surface water from the Upper Colorado River Basin to about 1,700,000 acre-feet per year. Almost all available surface water has been appropriated. Viable sources of water supply for coal production are limited to Lake Powell and to groundwater. In the Alton and North Kaiparowits lease areas, surface water is almost fully appropriated. Groundwater from the Navajo Sandstone appears to be the most viable source of water supply. Although the potential exists for development of groundwater from the Navajo Sandstone in the South Kaiparowits lease area, economic feasibility greatly favors the use of surface water from Lake Powell.

Surface water

Surface water flow in the various sub-basins within the study area is limited with an average annual runoff of less than 2 inches. Most of the region is drained by tributaries of the Colorado River. About 10 percent is drained by headwaters of the Sevier River. The Escalante River, Paria River, Virgin River, and the East Fork of the Sevier River are the principle streams in the region. Many streams are intermittent or ephemeral.

Precipitation and consequently the collection of surface water within watersheds is topographically determined. Higher elevations receive higher amounts of precipitation, especially in the form of snows. Snow is generally stored through most of the winter at higher altitudes and released as snowmelt during the spring and early summer. Snowmelt is the major contributor to streamflow. Groundwater also contributes to streamflow providing the base flow to perennial streams as well as some seasonal flow to intermittent streams. Although summer precipitation does not produce much runoff, intense localized thunderstorms can cause heavy flooding. Rainfall quantities for a rainfall of 6-hour duration with a probability of being equalled or exceeded once every 100 years, range from 3.5 inches at an elevation of 4,000 feet mean sea level to 6 inches at an elevation of 7,000 feet. Table 3-5 summarizes the peak flows expected for the 50-year and 100-year recurrence intervals for various sub-basins of the coal area. The sub-basins are numbered and outlined on Map 3-3.

Groundwater

The major aquifer underlying the coal lease areas is the Navajo Sandstone. This massive eolian sandstone contains substantial quantities of groundwater and is relatively undeveloped. Recharge rates to this aquifer are unknown but are thought to be low. Overlying the Navajo Sandstone are thick sequences of sandstone, siltstone, and limestone of various formations, some containing water. These formations do not appear to be hydraulically connected to the Navajo Sandstone and may act as confining layers in some areas. The dissected topography and limited areal extent of these upper formations make them unsuitable for groundwater development on a large scale. Development of the water resources of the Navajo Sandstone is hindered by the lack of reliable data concerning the occurrence and movement of groundwater in the formation. Existing areas of development are limited to a few deep wells and numerous springs, most of which lie outside the coal lease areas.

The potentiometric surface gradient of the Navajo Sandstone aquifer is predominantly southward. In much of the North and South Kaiparowits lease areas, depth to water is probably in the range of 2,000 to 2,500 feet based on the elevational locations of springs and data from one oil exploration well in the Escalante area. Depth to water in the Alton area is estimated to range from 1,200 to 1,500 feet based on the elevational locations of springs and potentiometric gradient and the interception points of wells from other studies. It is probable that adequate quantities of groundwater from the Navajo Sandstone could be developed in the Alton lease area and the southern section of the North Kaiparowits lease area. Wells located in these fractured areas of the Navajo Sandstone could yield from 500 to more than 1,000 gallons per minute.

Groundwater in the valley regions exists in the alluvium. This material has a moderate to high permeability. However, the alluvial deposits are very thin, with well production generally less than 50 gallons per minute on a sustained basis. Deeper alluvium exists in the Escalante River basin and in Johns Valley where sustained well yields of 500 gallons per minute might be possible.

Water Quality

In general the chemical quality of surface water is poorest in the southern portion of the study area. The surface water quality is relatively good in the headwaters to the north, with total dissolved solids (TDS) concentrations ranging from 100 to 500 milligrams per liter (mg/l). The quality deteriorates downstream, with TDS concentrations of 500 to 5,000 mg/l in the lower reaches. High suspended sediment concentrations are common in stream flows during snowmelt and storm runoff. However, the TDS concentrations are generally inversely proportional to flow, with the lowest TDS concentrations corresponding to the highest flow.

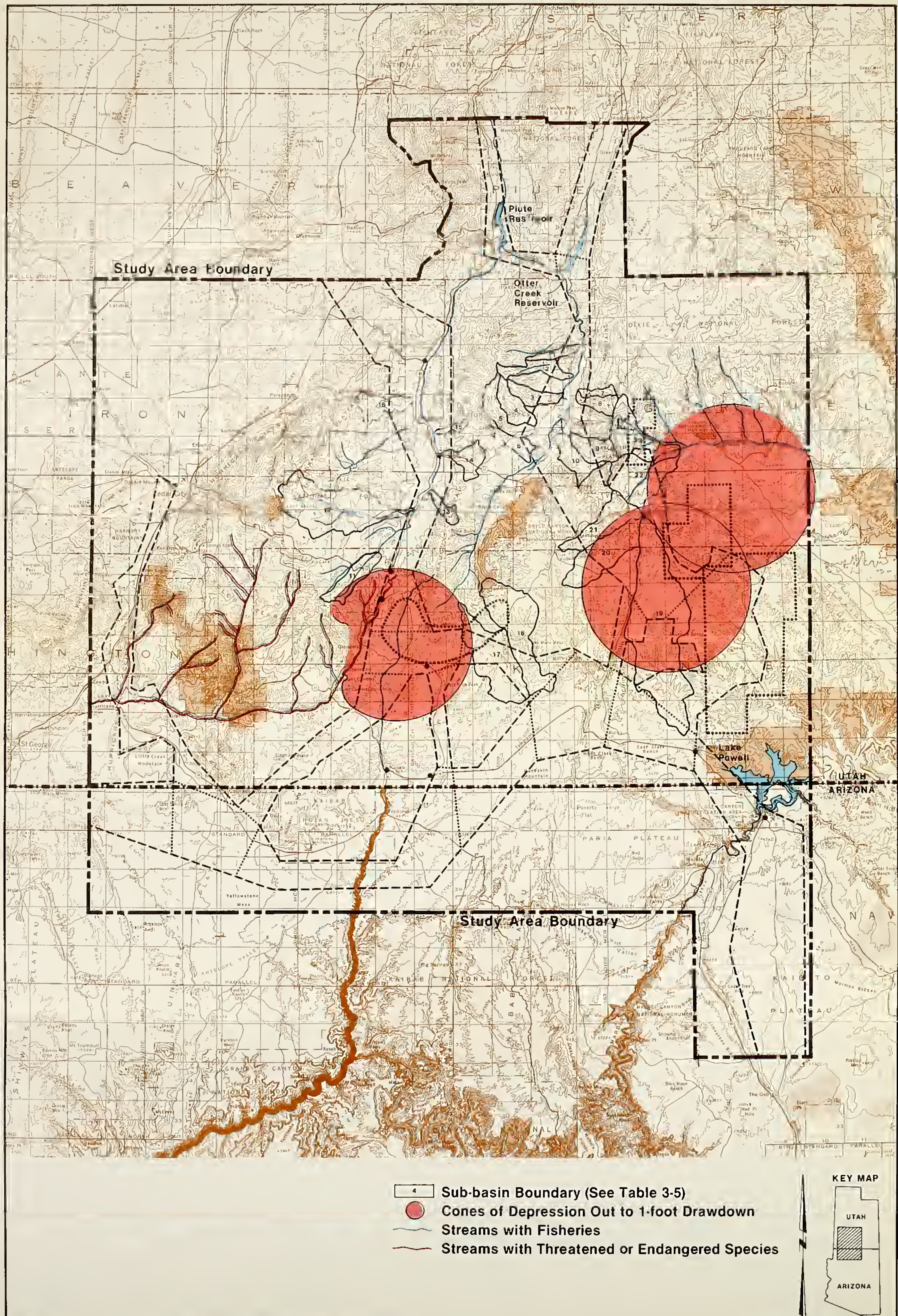
The chemical quality of the groundwater in the region varies depending on the aquifer. TDS concentrations in springs range from 200 to nearly 5,000 mg/l. In the Alton area, spring flow TDS concentrations average 250 mg/l. There is little available data on groundwater quality in the South Kaiparowits lease area. Springs in Cottonwood and Hackberry Canyons have as little as 500 mg/l TDS. Generally, the water from the groundwater system is believed to contain from 1,000 to 3,000 mg/l TDS. In the North Kaiparowits lease area, the groundwater quality in most aquifers is poor, with TDS concentrations as high as 4,710 mg/l. However, the Navajo Sandstone appears to be consistently good, varying from 500 to 1,000 mg/l TDS.

Vegetation

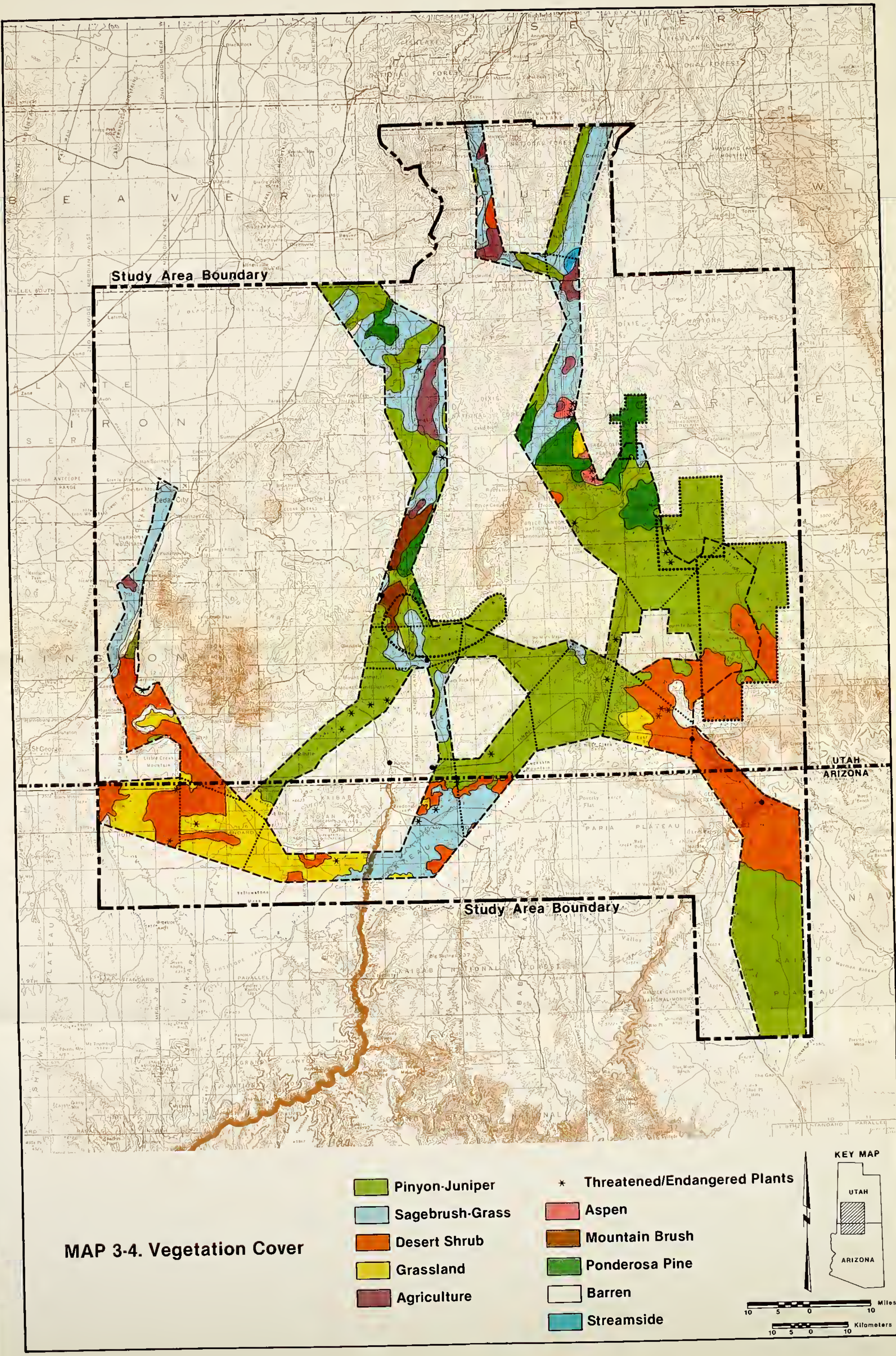
A total of ten land cover types are present in the corridors and coal lease areas considered in this analysis. Map 3-4 shows the distribution of these types over the study area and the locations of protected or candidate endangered plant species. Table 3-6 presents the relative percentage that each cover type occupies over the total study area and within each corridor segment. Since the majority of the study area was described in the Southern Utah Regional EIS (U.S.D.I., Geological Survey 1979), the following descriptions of cover types are quoted from that study. Additional information is provided for corridor segments that lie outside the region described in that EIS.

"The *Nonproductive* type includes areas of little if any vegetation-rock outcrops, large bodies of water, roads, railroads, conveyors, buildings, and urban development. Many of these areas are too small to map separately." Approximately 1 percent of the total corridor-coal lease area is occupied by this type (Table 3-6).

"The *Agricultural Land* type includes both irrigated and dryland farms, generally where soils are better in alluvial fans and valley bottoms. Because of the better soils, productivity



MAP 3-3. Hydrology and Important Aquatic Habitat



MAP 3-4. Vegetation Cover

TABLE 3-6
LAND COVER TYPES FOR THE TRANSPORTATION CORRIDORS AND COAL LEASE AREAS
(in percent)

Project Components[1]	Pinyon-Juniper	Sage-Grass	Desert Shrub	Grass	Aspen	Mountain Brush	Ponderosa Pine	Agricultural	Non-Productive	Stream-Side	Total
C1	.24	1.86	2.61	.41				.10	.64		5.86
C2		.03	1.56	1.39							2.98
C3			1.19	2.37							3.56
C4	3.93	4.37				1.22	1.12	1.09	.03		11.76
C5	.78	.41									1.19
C6	3.19			.24							3.34
C7	.41	3.15	.75	2.14							6.45
C8	.34	.58									0.92
C9	.37	1.12	.27					.61	.14		2.51
C10	1.93										1.93
C11	2.20	.68	.41								3.29
C12	1.05	1.76								.03	2.84
C13	6.88	2.98	.07	.24	.51		2.61	.58		.10	13.97
C14	4.31	.14									4.45
C15	1.09										1.09
C16	.95		1.59						.17		2.71
C17	1.15		1.15						.31		2.61
C18	7.09		4.78	.14							12.01
Alton[2]	2.64	.34				.20			.07		3.25
N. Kaiparowits[2]	3.32						1.12				4.44
S. Kaiparowits[2]	6.00	2.78									8.78
TOTAL	47.87	17.42	17.15	6.92	.51	1.42	4.85	2.37	1.36	.14	100

Source: ERT Project Team
[1] Corridor segments, C1 through C18
[2] Coal lease areas

is higher than in the other vegetative types. Crops vary from dry and irrigated pasture to hay, small grains, some row crops, and a few orchards. Precipitation ranges from 6 to 16 inches per year and is usually supplemented by irrigation water. Very few acres of this type are in the region. Ground cover varies with the crop and the season, although it is usually good to excellent during the growing season, unless the land lies fallow in summer. Poor ground cover prevails after harvest". Approximately 2 percent of the total corridor-coal lease area is occupied by this type (Table 3-6).

"The *Streamside* type occurs along the edges of streams and ponds or in areas of high water table. It includes areas that may be flooded. Sedges, rushes, horsetails and cattails grow adjacent to the water, along with willows, cottonwoods, saltcedar, and greasewood. Pondweed, algae, and mosses grow in the water. Soils are generally deep, soft waterlaid sediment. Although widely scattered, very few acres of this type are in the region. This type grows within all precipitation ranges where streamflow provides enough moisture. It is found with or next to all other vegetative types. Because of the deep soils and high moisture content, this type produces an abundance of growth, which provides good to excellent ground cover". Less than 1 percent of the total corridor- coal lease area is occupied by this type (Table 3-6).

The *Desert Shrub* type consists of a mixture of several shrub species. In the northern portion of the region this mixture consists of shadscale, rabbitbrush, and big sagebrush. In the southwestern portion of the region near St. George, cresote brush becomes important. Productivity on this type is generally sparse, and is limited by low (6 to 12 inches) annual precipitation. The desert shrub type predominates on shallow rocky soils on slopes and extends out onto deeper soils in valleys at low (less than 5000 feet) elevations. Approximately 17 percent of the total corridor-coal lease area is occupied by this type (Table 3-6).

"The *Grassland* type is scattered through the lower elevations, but also includes seeded grasses in range-improvement projects at all elevations. Native grasses include galleta grass, sand dropseed, wheatgrasses, and three awn, along with lesser amounts of forbs and shrubs. Ground cover and production are generally low in the native grasses because of past disturbance. The seeded grasses are primarily crested wheatgrass at lower elevations and various mixtures at higher elevations, including intermediate wheatgrass, orchard grass, bluegrass, smooth brome, and Indian ricegrass. Ground cover and production vary

from poor to good, depending upon the species, management, precipitation, and success of seeding. The type grows in a range from 6 to 16 inches of annual precipitation. Soils are usually moderately deep and well drained". The grassland type occupies approximately 7 percent of the total corridor-coal lease area (Table 3-6).

"The *Sagebrush-Grass* type generally grows between the Desert Shrub type and the Pinyon-Juniper Woodland type. Because sagebrush is aggressive, this type often extends through other types at lower altitudes along alluvial deposits and may grow at altitudes of 9,000 feet. The community is variable, but generally occupies the deeper, more permeable, salt-free soils of well-drained valleys and foothills. It grows where precipitation exceeds 12 inches annually or where ample ground water is available. Species include big sagebrush, black sagebrush, rabbitbrush, Indian ricegrass, wheatgrass, Sandberg bluegrass, needlegrass, and blue grama. Where undisturbed, this type provides moderate ground cover and fair to good production. Much of the agricultural lands were once covered by the Sagebrush-Grass type". Approximately 17 percent of the total corridor-coal lease area is occupied by this type (Table 3-6).

"The *Pinyon-Juniper Woodland* type forms an open forest, with trees 10 to 30 feet high. Shrubs, grasses, and forbs constitute a generally sparse understory, although dense stands of shrubs may occasionally be found on sites of high moisture content. This community mixes considerably with Sagebrush-Grass or alternates with it. Generally sandy, gravelly, or rocky soils prevail. Precipitation averages between 10 and 14 inches annually. This is the most common and most widespread vegetative type in the region and occupies vast areas at medium elevations. Utah Juniper, Rocky Mountain juniper, and pinyon pine in various mixtures generally form the overstory. Buffaloberry, bitterbrush, cliffrose, sagebrush, galleta grass, and Indian ricegrass form the understory. Productivity is generally low to moderate. This vegetative type is most often chosen as sites for revegetation projects to benefit livestock and wildlife". Approximately 48 percent of the total corridor-coal lease area is occupied by this type (Table 3-6).

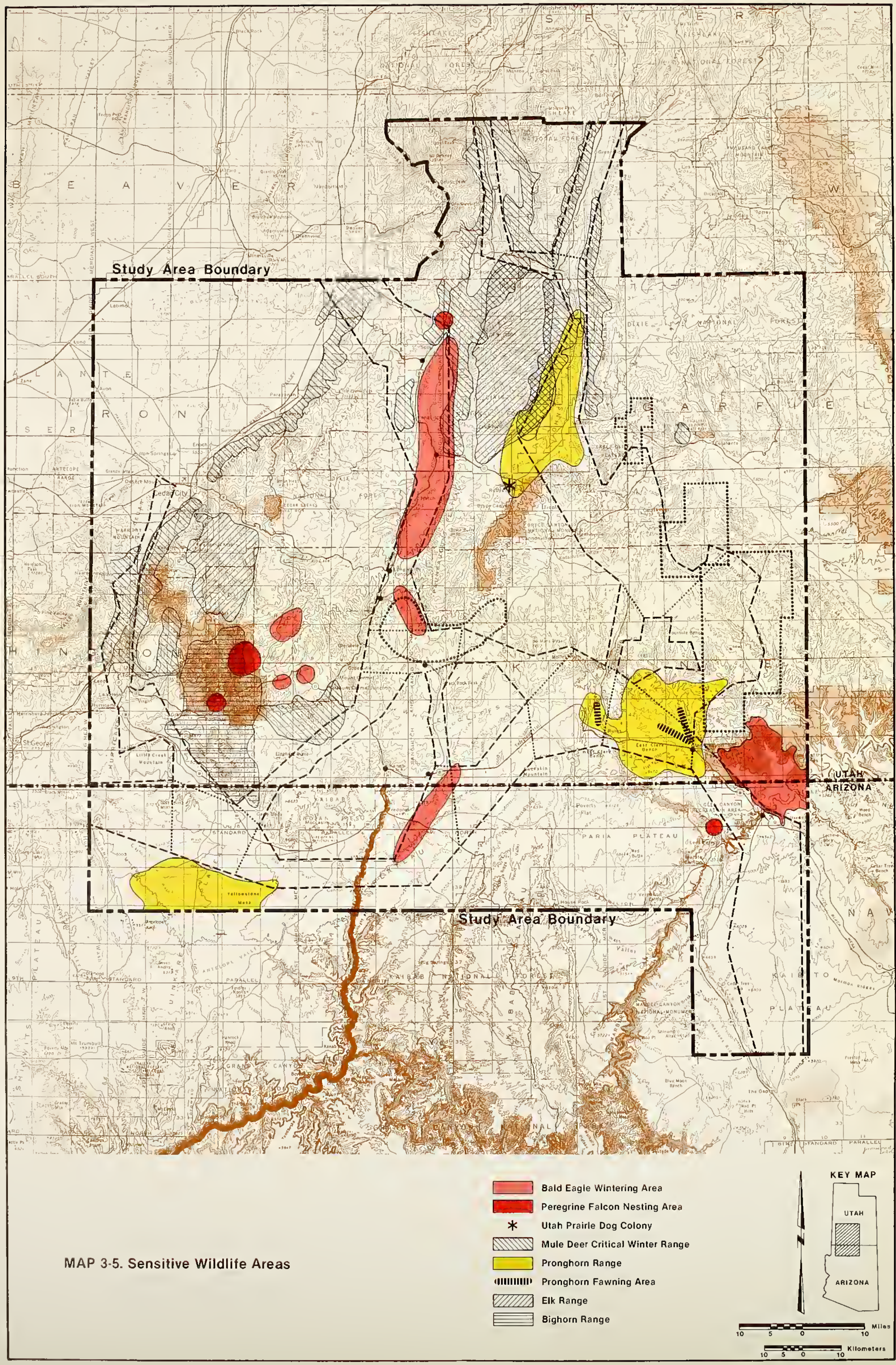
"The *Mountain Brush* type generally grows at altitudes higher than the Pinyon-Juniper Woodland but may alternate with that type and includes ponderosa pine stands. Dominant species differ with location, and several species may grow at the same altitude. Deeper soils may allow sagebrush and grasses to join the overall community. This vegetative type has a wide range of soil tolerance but generally grows on moderately deep, medium textured, well-drained soils. Common species are Gambel oak, mountain mahogany, mountain maple, sagebrush, bitterbrush, serviceberry, chokecherry, snowberry, bluebunch wheatgrass, and needle-and-thread grass. Ground cover and productivity are moderately high." The Mountain Brush type occupies approximately 1 percent of the total corridor-coal lease area (Table 3-6).

"The *Ponderosa Pine* type is dominated by this tree. When mature, these large trees typically develop open, parklike stands, with a light understory of brush and (or) grass. The type normally occupies favorable sites between the Mountain Brush and Conifer-Aspen types, although individual trees or groups grow with the other types. Precipitation ranges from 15 to 20 inches annually. A wide variety of soils support the type, but it prefers moist to dry gravelly loams. Other species include juniper, pinyon, Gambel oak, bearberry, bitterbrush, manzanita, seviceberry, slender wheatgrass, and oatgrass. Ground cover and productivity are generally good. This type, like other timber types, occurs on scattered sites at higher elevations." The Pondersoa Pine type occupies approximately 5 percent of the total corridor-coal lease area (Table 3-6).

"The *Aspen* type grows mixed with Douglas fir, white fir, and spruces over much of their common ranges. Occasionally, aspen dominates an area large enough to be mapped as a separate type. These pockets of aspen usually grow along streams, depressions, or flats, where soils are deep and moisture is abundant. Annual precipitation ranges from 20 to 40 inches. The conifers previously mentioned plus sagebrush, bluegrasses, Oregon grape, arnica, and larkspur grow in the aspen stands. Ground cover is generally good to excellent, and productivity is high." The aspen type occupies less than 1 percent of the total corridor-coal lease area (Table 3-6).

A number of plants with very limited habitats have evolved in the project region. These plants often grow on outcrops of certain geologic formations or on wet areas near widely scattered springs. Many of these plants are known from very few locations and are currently being reviewed for protection under the Endangered Species Act. One plant species, (*Pediocactus sileri*), is protected as endangered. This cactus is known from the Arizona portion of the study area.

Thirty-nine species in the five Utah counties and three in Coconino County, Arizona, are expected to be listed as candidate species in the U.S. Fish Wildlife Service notice of review to be published in the summer, 1980 (Dr. James Miller, Dr. Arthur Phillips, personal communi-



MAP 3-5. Sensitive Wildlife Areas

cation 1980). As candidates, they are afforded no legal protection. However, it is expected that most, if not all, of the candidate species will be elevated to the status of "proposed" in the near future (John Fay, personal communication 1980) and will thus become legally protected. Tables C-1 and C-2 in the Appendix C list the 1 endangered and 42 candidate species known to occur in the study area, the counties in which they occur, and general habitat descriptions for each.

Wildlife

Terrestrial

The wildlife communities of the Kaiparowits study area are typical of the intermountain habitats described in the vegetation section. This range of habitats supports a wide variety of animal life including 86 species of mammals, 328 species of birds, 36 species of reptiles, and 11 species of amphibians (USDI 1979). Dalton et al. (1978) have compiled a list of vertebrate species of southwestern Utah and their habitats. For purposes of this regional planning study only species of significant interest that may be affected are discussed.

Mule deer are the most numerous and widespread big game animal within the study area; however, similar habitats in other parts of the southwest support higher populations (UDWR 1979). Range condition is good (UDWR 1979) and could support increased browsing. Carrying capacity is approximately 1 animal per 100 acres (USDI, BLM 1978). As winter severity increases, mule deer tend to move to lower elevations. Map 3-5 shows deer concentration areas during more severe winter periods. This tendency concentrates animals near major highways. From July 1, 1970, through June 30, 1978, an average of 170 deer per year were reported killed by vehicles in and near the study area (UDWR 1979). This figure must be considered a minimum since many animals wander off the highways after being struck and die elsewhere.

Elk populations are limited within the study area (Map 3-5) and, relative to other populations in the state, are low in number. Maximum carrying capacities of occupied habitat are approximately 1 animal per 100 acres (USDI, BLM 1978). The largest herd is in the Mount Dutton unit between Sevier Valley and Johns Valley. This herd is expanding into neighboring areas.

Pronghorns occur in limited numbers in Johns Valley and on Easl Clark Bench (Map 3-5). Populations are at or below average with respect to similar habitats in the Intermountain region. A small population of bighorn sheep inhabit Zion National Park. Historically, sheep were widespread across the study area.

Mountain lions are found throughout the study area and their populations are high with respect to other areas of similar habitat. Deer management units wholly or partially contained within the study area contributed 34 percent of the state's mountain lion harvest in 1976-77 (Fair 1977).

Endangered, threatened, rare, or unique species also inhabit the study area. Bald eagles, an endangered species, are winter visitors in the region and throughout the Glen Canyon National Recreation Area (see Map 3-5). Winter roost sites exist in Cedar and Parowan Valleys and at Escalante Bay on Lake Powell. An inventory of these sites in January and February 1977 recorded 64 bald eagles at eight sites (Boner et al. 1977). Bald eagles also winter in Sevier Valley.

The American peregrine falcon is also endangered. The study area is part of the known and suspected breeding distribution of the peregrine falcon in Utah (Porter and White 1973). Most sightings in recent years were probably migrant birds; however, several nest sites (mostly inactive) are present in the study area. No active nest sites have been documented in the coal production areas or transportation corridors.

The Utah prairie dog, an endangered species, is found in the study area. The principal concentrations of prairie dog towns are in Parowan and Cedar valleys, the Bryce Canyon-Johns Valley area, and Sevier Valley from Panguitch to Long Valley Junction (Map 3-5). The fall 1977 census yielded the largest count (3,429 dogs) since the Utah Division of Wildlife Resources (UDWR) began such counts in 1975. This increase is attributed to the discovery of new towns and establishment of transplant sites on public lands (Boner et al. 1977).

Rare or unique birds (UDWR classification) include the osprey and spotted owl. Osprey are summer residents and migrating birds also pass through in spring and fall. Spotted owls have been sighted in Zion and Capitol Reef National Parks during surveys in 1977. They may currently be nesting in Zion National Park (Boner et al. 1977).

The unique (UDWR classification) spotted bat has been sighted in Garfield, Kane, and Washington Counties (Poche 1976, Easterla 1965). Fort Pierce Wash in southern Washington County (just outside of the study area) may support the largest spotted bat population in Utah. Studies in other parts of the region failed to locate spotted bats (Boner et al. 1977).

Habitat diversity of the study area lends itself to a variety of other wildlife. Furbearers such as beaver, mink, and muskrat exhibit relatively low populations and are not trapped extensively. Many species of raptors including golden eagles and red-tailed hawks inhabit the area and are important because of their size and general conspicuousness. Upland game birds, like sage grouse and turkey, and waterfowl are found within the study area but in relatively low to moderate numbers. Carrying capacity of occupied habitat appears to be 1 gamebird per 5 acres (USDI, BLM 1978). Small mammals, such as mice, rats, and squirrels, and various song birds are distributed throughout the region. Carrying capacities for appropriate habitats are 4 to 6 small mammals and 2.5 songbirds per acre (USDI, BLM 1978).

Aquatic

The wide range of elevation and rainfall in the study area results in different aquatic habitats. However, annual precipitation and aquatic habitat is relatively limited compared to other U.S. coal producing areas. Forested watersheds drained by high gradient streams typical of the Rocky Mountains compose the head waters of the larger permanent streams. Streams originating at lower elevations where runoff is low per unit area are frequently intermittent. When flowing, these streams are usually warm and saline with sand and silt substrates. Larger streams also change at lower elevations (as a result of changes in gradient, irrigation dewatering, and evaporation) to shallower, warmer streams with fine substrates.

Essentially two types of aquatic habitat occur in the study area: mountain streams populated by cold-water species (such as trout) and warm-water plains streams containing primarily warm-water species (such as suckers and shiners). Streams supporting fisheries are delineated on Map 3-3. Intermittent streams seldom support any fishes unless permanent pools remain in dry years. Lower aquatic organisms such as algae and aquatic insects are common in the pools that remain in these streams.

The food base of the permanent streams with rocky or gravelly substrates is primarily algae which grow on the substrate, but detritus of terrestrial origin may also be important. Intermediate organisms in the food web are primarily aquatic insects. The lower gradient fine substrate streams do not provide as much suitable substrate for algae as rocky substrate streams, thus terrestrial detritus is relatively more important than algae in these streams. Since fine substrates are less suitable as aquatic insect habitat due to substrate instability, the lower gradient stream sections are much less productive than rocky substrate streams.

Whereas cold-water game fish are frequently found in the cool mountain streams, lower warm-water segments seldom support corresponding warm-water game species because irrigation dewatering, fine substrates, and shallow depths are unsuitable. The Sevier River tributaries, the North and East forks of the Virgin River and their larger tributaries, Kanab Creek, and the permanent Escalante River tributaries all support varying-size trout populations. Species present are cutthroat, rainbow, brown, and occasionally, brook trout. The small size of most of these streams, coupled with limited access, limits their value as sport fisheries.

Lower elevation streams support primarily small fish species such as speckled dace, red shiners, fathead minnows, and green sunfish, while some of the larger streams support larger warm-water species such as flannelmouth, bluehead, and desert suckers and roundtail chub. Several other large species such as carp or bullheads are also present in some streams, especially those draining into Lake Powell.

Lake Powell supports a large assemblage of warm-water game fish species including largemouth bass, black crappie, channel catfish, and walleye. High levels of mercury, selenium, and lead have been reported from tissues of some of the larger game species by Standiford et al. (1973) and Bussey et al. (1976). Bussey felt that high lead levels were the result of outboard motor exhausts, but in view of the high selenium and mercury levels naturally present in surrounding substrates, it is likely that high tissue lead levels are also the result of natural causes.

Several fishes classified as endangered by either Federal or state authorities are found in limited portions of the study area. Map 3-3 depicts locations and streams containing classified fishes. The Federally-endangered woundfin is found only in LaVerkin Creek and the Virgin River below LaVerkin Creek. Except for the lower portion of LaVerkin Creek and a small section of the Virgin River near Hurricane, none of the woundfin habitat lies within any of the transportation corridors. The state-endangered Virgin River roundtail chub has a similar distribution; however, the state-endangered Virgin River spinedace is found throughout the tributaries to the Virgin River. These contrasting distributions reflect the

sandy substrate preference of the woundfin and Virgin River roundtail chub and the gravel/cobble substrate preference of the Virgin River spinedace.

Three Federally-endangered large-river species, the Colorado squawfish, humpback chub, and bonytail chub, and one state-endangered large-river species, the razorback sucker, have historically inhabited the Colorado River in the area that is now Lake Powell. Since these species prefer or require river habitat, they are rarely found in Lake Powell, but are present in the river above the reservoir. These species are not known from the lower portions of rivers tributary to Lake Powell within the study area and have been eliminated from the Colorado River below Lake Powell because of cold water release.

Paleontological Resources

The study area is located on the Colorado Plateau which is characterized by expansive exposures of fossil-bearing sedimentary rocks. Of the various rock types occurring in the study area, only the sedimentary bedrock has a realistic probability of yielding significant fossils. The sedimentary bedrock consists of seventeen recognized geological formations, ranging in age from Early Permian (280 million years) to Late Tertiary (2 million years). A paleontological summary of these formations is given in the Appendix D. Observations made largely outside of the study area indicate that in most of these formations, fossils tend to occur in isolated pockets, separated by wide horizontal and vertical expanses of unfossiliferous rock. Most of the formations exposed in this region have been examined for fossils, and some (e.g., Chinle Formation, Moenkopi Formation) have received intense detailed attention.

Sensitivity ratings were developed to estimate the probability of encountering significant paleontological resources within the study area. A summary of formations within each sensitivity rating is included in Table 3-7.

TABLE 3-7
PALEONTOLOGICAL SENSITIVITY OF GEOLOGICAL FORMATIONS IN THE STUDY AREA

Formations	Sensitivity
Moenkopi	Maximum[1]
Chinle	Maximum
Kayenta	Maximum
Kaiparowits	Maximum
Wasatch	Maximum
Kaibab Limestone	Major[2]
Moenave	Major
Navajo Sandstone	Major
Carmel	Major
Winsor	Major
Tropic	Major
Curtis	Moderate[3]
Dakota Sandstone	Moderate
Wahweap	Moderate
Straight Cliffs Sandstone	Moderate
Sevier River	Moderate
Entrada Sandstone	Minimum[4]

[1] Maximum: Areas with significant communities or individual organisms (e.g., vertebrates) in abundance and which have been afforded some form of legal or statutory protection.
[2] Major: Includes significant fossil communities or individual organisms (e.g., vertebrates) which occur in abundance and are likely to be encountered.
[3] Moderate: Includes rocks which contain abundant remains of fossil organisms, chiefly invertebrate, some of which may be significant and will almost certainly be encountered.
[4] Minimum: Includes volcanic and igneous intrusive rocks and unconsolidated Quaternary Age sediments such as stream alluvium and sand dunes, which are known to possess only an extremely low probability of yielding significant fossils; geological formations containing sparse concentrations of insignificant fossils; or formations which may/have yield(ed) significant material but the known or projected abundance is low, so that the probability of encountering them is remote.

Archaeological Resources

Regional Prehistory

Aboriginal utilization of the study area has been documented for each of the prehistoric stages known for the Colorado Plateau, the Paleo-Indian, Archaic, Puebloan, and the Numic (Hauck 1979; Jennings 1978). These stages range from 10,500 B.C. or earlier to the historic present. The Paleo-Indian peoples (9,500 to 6,000 B.C.) were hunters and gatherers. Undisturbed and identifiable artifacts from this period are rare and very informative. The Archaic occupation was characterized by the orientation of band groups toward the collection and hunting of a wide range of wild foodstuffs. Sites from this period tend to be small, inconspicuous, and easily damaged. There is evidence of Archaic occupation throughout the study area, particularly in the western and northwestern portions.

Two distinct Puebloan peoples occupied the study area, the Fremont and the Anasazi (Jennings 1978; Judd 1926). Groups of the Fremont culture were centered around areas in the Cedar and Parawon Valleys and the middle reaches of the Sevier River valley. Groups

of Anasazi cultural were situated to the south and east of the Fremont, around agricultural areas in the Virgin River, Kanab Creek, Paria River, Wahweap Creek, and Escalante River drainage areas and the Kaiparowits Plateau. The Puebloan abandonment of the study area by the 13th century coincided with the arrival out of the Great Basin of a people called Numic or Shoshonean (Madsen 1975). This population was oriented to an essentially archaic hunting/gathering lifeway. Sites dating to this period are often small and ephemeral, lack substantial structural remains, and may be difficult or impossible to identify as Numic if diagnostic artifacts such as brownware ceramics and small side-notched arrow points are absent. Numic sites have been found in relatively small numbers throughout much of the study area. These sites are valuable in their potential for expanding the rather scanty substantive knowledge of the period. The Numic occupation is currently best understood through analogy and continuity with ethnographic knowledge of the Southern Paiute, the historic and modern representatives of the Numic peoples still living in the study area (Kelly 1964).

Regional History

European exploration in the study area began in 1776 with the Dominguez-Escalante Expedition's unsuccessful, but highly informative, attempt to establish a route between Santa Fe and southern California. The explorations formed the basis for the establishment of the Old Spanish Trail, which prior to 1850 was a major westward route for trappers, explorers, and settlers. The Trail crossed the northwest portion of the study area between Marysvale and Cedar City. The area of south-central Utah and the Arizona strip, especially towards Glen Canyon, was little known even by the mid 1800s (Gregory and Moore 1931).

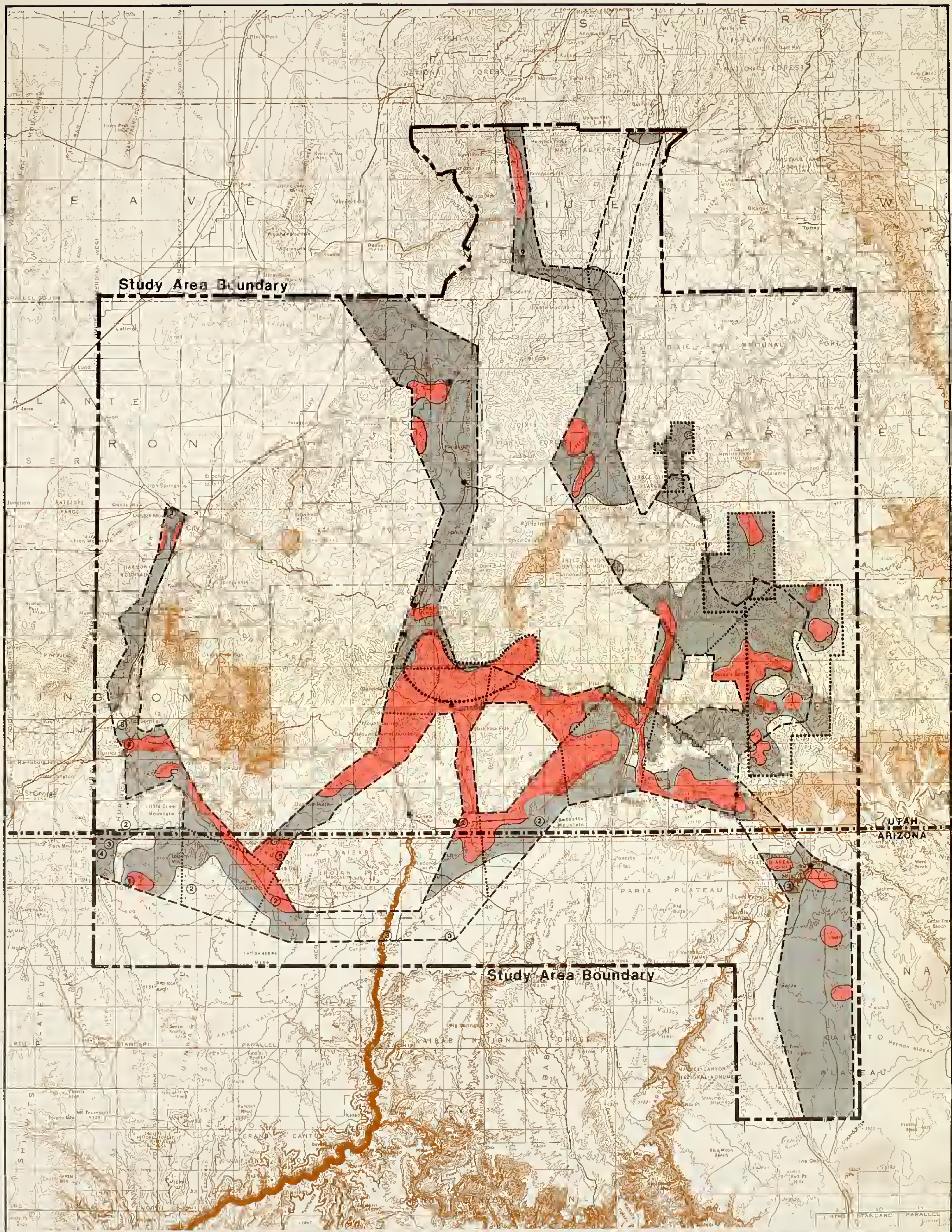
Settlement of the region began in 1849 with well-organized Mormon colonization efforts. First established was a series of settlements down the western side of the High Plateaus, with Parowan as the key permanent settlement (Hauck 1979). In the 1860s and 1870s, settlement was subsequently extended eastward to a number of favorable locations including Kanab, Panguitch, and Escalante. The key settlements in southwest Utah also served as the base, via the Honeymoon Trail out of St. George, for settlement of the Little Colorado Valley and eastern Arizona. A regional economy based on irrigated agriculture, stock raising, lumbering, and freighting supported a population that grew steadily into the 1920s.

Resource competition from Anglo settlers and limitation of access to certain key resource locations marked the end of an adaptive archaic hunting/gathering lifeway for the Southern Paiute. The survivors of the settlement period were greatly reduced in numbers from their pre-contact population level (Stoffle and Evans 1976). Navajo utilization of the region west of the Colorado River has never been more than transitory and has been primarily oriented to Anglo and Paiute presence in the area. There was little if any Navajo incursion into the area prior to the mid-nineteenth century (Hester 1962). Stable Navajo settlement of the Kaibito Plateau and Cornfield Valley areas began late in the 19th century (Adams 1963).

Archaeological Site Sensitivity: Prehistoric

Map 3-6 depicts expected archaeological (pre- and ethnohistoric) site densities for the study area in relative terms of low, medium, and high densities. The rankings are a measure of the expected probability of any kind of site being encountered within a given amount of land area. Expected densities were generated from an evaluation of survey and excavation data available from site files and the literature, specialists' knowledge and opinion, and the distribution of relevant topographic, hydrologic, and edaphic environments within the study area. For example, the immediate areas around springs, areas suitable for prehistoric farming, and known site clusters are indicated as areas of high expected archaeological density. Areas of very high elevation, shale badlands, and areas which have yielded negative survey results are indicated as areas of low expected site density. Other areas, especially those between 6,000 and 8,000 feet in elevation, are indicated as having medium expected site density. Also included in this latter category are areas for which survey data are lacking and for which environmental indicators do not provide a reasonable basis for projecting a more specific site density. Some of the areas are known to contain clusters of archaeological sites; these sites are not delineated in Map 3-6 but the existence of these sites influenced the density ratings.

The distributions in Map 3-6 show only the expected relative densities of total numbers of sites. Although site density may be equated with archaeological sensitivity in a general way, variables such as site type, size, location, condition and individual significance may modify the actual archaeological sensitivity of a particular area. Table 3-8 summarizes information on archaeolog-



MAP 3-6. Archaeological Site Density

High (> 11 sites/sq. mi.)
Medium (1-11 sites/sq. mi.) or Unknown
Low (< 1 site/sq. mi.)
② National Register Site

Note: The site densities on this map are generalized. Small areas with projected high densities and/or known site clusters exist that have not been delineated on the map to protect them from vandalism.

10 5 0 10 Miles
10 5 0 10 Kilometers

TABLE 3-8
ARCHAEOLOGICAL SENSITIVITY IN THE STUDY AREA

Corridor No./Coal Field	Cultural Period(s)	Condition of Site(s)	Predominant Site Density	Survey Data
C1	Archaic, Paiute, Fremont, Virgin Anasazi	Disturbed	Medium	Representative for specific areas, poor elsewhere
C2	Archaic, Virgin Anasazi	enerally undisturbed	Medium/Low	Fair
C3	Virgin Anasazi	Generally undisturbed	Medium/Low	Fair
C4	Fremont, Archaic	Variable	Medium	Spotty, absent for large areas
C5/Alton Coal Field	Archaic, Virgin Anasazi, Paiute, Navajo	Generally good	High	Good
C6	Virgin Anasazi	Generally good	High/Medium	Fairly good
C7	Virgin Anasazi	Generally undisturbed	Low	Fair
C8	Virgin Anasazi	Good	High	Good
C9	Fremont	Disturbed	Medium	Spotty
C10	Similar to C5 in upland portions; simmilar to C8 in and adjacent to canyons	Good	High	Good in northwest portion and in Kitchen Corral Canyon
C11	Virgin Anasazi, various other groups	Good	High/Medium	Good along southeast transect, spotty elsewhere
C12	Fremont	Variable	Low	Good along transect on east side of valley
C13/ N. Kaiparowits Coal Field (N. portion)	Fremont, Virgin-Kayenta, Anasazi	Good	Medium/Low	Good
C14	Virgin Anasazi, various other groups	Good	High/Medium	Fair
C15	Virgin-Kayenta, Anasazi	Deteriorated by natural erosion and vandalism	High/Medium	Good on transect along base of Cockscomb
C16	Virgin, Kayenta Anasazi	Deteriorated by natural erosion	High/Medium	Good for limited areas
N. Kaiparowits Coal Field (S. portion)	Kayenta Anasazi	Variable	Medium	Good in northern half
S. Kaiparowits Coal Field	Virgin, Kayenta Anasazi, Paiute	Fair to good	Medium	Good for Nipple and Four Mile Benches areas, poor in other areas
C18	Kayenta Anasazi, Navajo	Variable	Medium	Good

Source: ERT Project Team

TABLE 3-9
SITE ON/OR NOMINATED TO NATIONAL REGISTER OF HISTORIC PLACES

Map Ref.	Corridor Segment	Name	Description
Arizona:			
1	C2	Antelope Cave (NR)	Prehistoric (Archaic, Basket-maker and Pueblo) cave site, NA5,507.
2	C2,3,7,11	Honeymoon Trail (NR)	Mormon settlement route, St. George-Kanab-Little Colorado Valley via House Rock Valley.
3	West of C2, C7, 8	Dominguez-Escalante Trail	Spanish exploration route, 1776-7.
4	West of C2	Temple Trail	Mormon lumbering (1871-6) and settlement route, St. George-Mt. Trumbull
5	C6	Bar Z Ranch	Historic ranch site.
Utah:			
6	C9	Paiute County Courthouse (NR)	Two story brick structure within town of Junction
7	C1	Fort Harmony (NR)	Foundation walls and inter pretive monument, pioneering fort location.
8	C1	Hurricane Canal (NR)	Pioneering water project for town of Hurricane. It is well preserved, with much of it still in use.

Source: ERT Project Team

ical content, condition, and survey adequacy which, along with information in Map 3-6 and the regional background outlined above, is necessary to describe the affected archaeological environment and archaeological sensitivity in the study area.

Archaeological Site Sensitivity: Historic

Historic sites recorded in the study area include campsites, cabins, farm and ranch complexes, forts, community settlements, commemorative locations, inscriptions, trails and wagon roads, stock enclosures, and mines. To this should probably be added water control features, kilns, lumbering facilities, graveyards, and isolated items of rolling stock. There is little clustering of recorded sites by area within the region (Hauck 1979); however, there is a strong tendency for sites to be located in valley areas in contrast to other topographic zones.

The exact alignments of historic trails are often difficult to define due to ground cover changes, erosion, or obliteration by modern roadway. Often only particular locations such as springs and passes or extensively graded route segments remain identifiable. The dugway through the Hurricane Cliffs, for instance, is a particularly well preserved portion of the Honeymoon Trail.

An accurate estimation of historic site density cannot be projected from the data available. Watered areas, alluvial canyon bottoms, and the broad valleys at moderate elevation (where most modern occupation is centered) can be expected to have an overall moderate site density. A high density of sites can be expected to be found in and around pioneer settlements and associated activity areas. Many of these locations remain a focus of modern occupation. More widely scattered remains of early 20th century homesteading can be found in a number of less favorable areas, such as the expanses south of Colorado City.

National Register Properties

Table 3-9 lists the sites within the study area that are included on or nominated to the National Register of Historic Places. This information was obtained by consultation of the files of the Utah Division of State History and the Arizona State Historic Preservation Office. Site locations are shown on Map 3-6 according to the map reference numbers. There are additional historic and prehistoric sites in the study area potentially eligible for inclusion on the National Register under the criteria given in Title 36 CFR 1202.6 (formerly 60.6).

Native American Concerns

Native American groups identified as having sacred cultural resources in the study area that could be potentially impacted by Kaiparowits coal and transportation development include the Kaibab Paiute, Koosharem Paiute, Kanosh Paiute, Cedar City Paiute, Shivwits Pauite, San Juan Paiutes (including the Willow Springs and Navajo Mountain groups), and the Navajo Nation. These are the living Native American groups that represent those groups residing in the study area at the time of contact with Euro-American society. The historic boundaries of these groups are presented by Kelly's (1934) map of Southern Paiute Bands (see Appendix E).

The following discussion is based on ethnographic and ethnological analysis of religion and is generally accepted by professional anthropologists. Human groups vary in the degree to which they define portions of their society, culture, and material resources as sacred rather than secular. When compared with many other ethnic groups in contemporary United States society, Native Americans generally define more of their social, cultural, and material resources as sacred. Among sacred resources or sociocultural patterns, some can be more important than others and this relative importance can be changed over time by group consensus. Inasmuch as the sacredness of these resources can and does change through time, no assessment of Native American sacred resources is complete without consulting with the potentially impacted group. Therefore, a Native American group can define as sacred a wide range of resources from food, to places, to activities, to ancestorial burials.

Some Native Americans continue to live on their traditional homelands while other groups within the study area still live near their ancestoral lands that were left only within this century. A strong correlation exists between archaeological site distribution/density and oral accounts of the importance of various traditional Paiute communities. The following are summaries of the specific concerns expressed by Native American peoples from throughout the study area. The listing is alphabetical so as not to imply a ranking among the concerns. More is known about the Paiute concerns because, at the time of this report, no official response to the scenario had been approved by the Navajo Tribal council.

- *Artifacts.* Heavy artifacts were normally left at traditional camping sites in anticipation of the group's seasonal visit, while other artifacts were stored in caves or rock shelters. Although return to these camp sites has been blocked in many cases by Euroamericans, living Indian people still know the location of the sites and claim ownership of the artifacts.
- *Animals.* Strong concern was expressed for animals of the area that are still significant in the diet of certain local people and figure significantly in Paiute legends (Palmer 1946) and religion. These include badger, bear, beaver, blue jay, cottontail rabbit, coyote, deer, dove, eagle, hawk, hummingbird, jackrabbit, mountain sheep, rattlesnake, owl, packrat, porcupine, quail, sagehen, skunk, squirrel, and swallow. Given the uneven distribution of animals in Southern Paiute territory it can be assumed that other species would be mentioned as more local groups of Indian people were interviewed.
- *Burials.* Until recent times, depending on the Native American group, burial of the dead was conducted in a traditional fashion in a traditional location. Therefore, the great majority of the Paiute burials are not located in recognized cemeteries; this is probably true for the Navajo people also. It is assumed that all portions of the study area contain burials of recent origin and of contemporary concern until specifically "cleared" by official Native American group representatives and families who lived or live in the locale. This assumption is based on the fact that such burials have been recorded in every segment of the study area where expert consultants could be interviewed.
- *Petroglyphs and Pictographs:* Symbols, both life-like and abstract, have been

pecked (petroglyphs) and painted (pictographs) in caves and along sheltered ledges in the study area. While some of these are attributed to the early Puebloan peoples, many are more recent and therefore recognized as being created and belonging to living people.

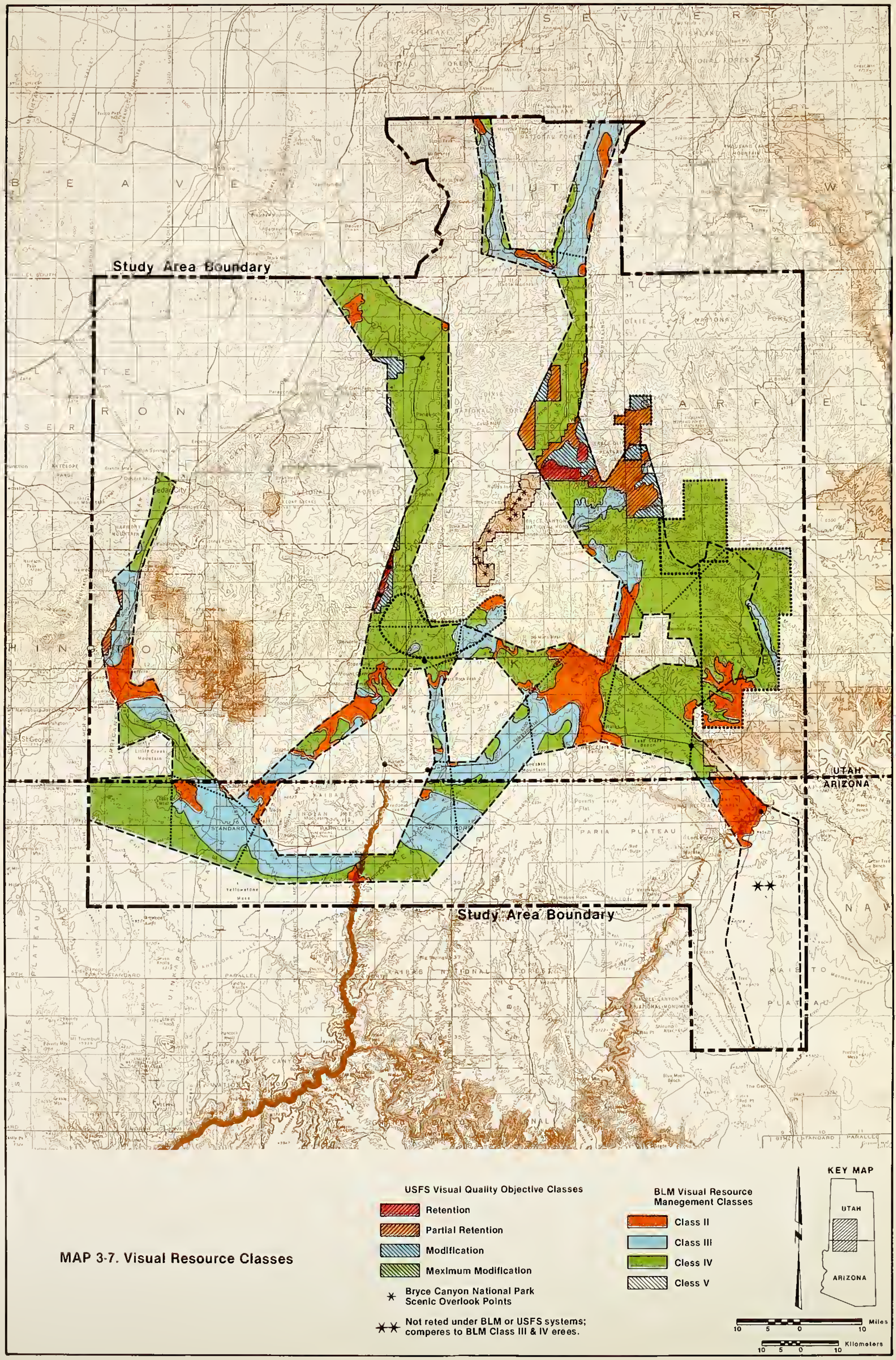
- *Places:* The academic literature contains a reasonably complete record of the major sacred places for groups like the Navajo people (Jett 1970, 1973). For the remainder of the Southern Paiutes and local groups of Navajo people in the study area, however, there is no published record of the sacred locations. For the Southern Paiute in the study area a number of places of concern were recorded during the study.
- *Plants:* Native Americans continue to use many plants located in the study area for food, medicine, ceremonies, and income. Navajo people regularly visit portions of the study area (especially near Johnson Canyon and the upper portion of Kanab Creek Canyon) to gather plants such as purple sage that are needed for ceremonial and basket-making purposes. Native American plants that are gathered from the study area are a major part of the Kaibab Paiute's ceremones and still contribute to medicine and diet. Native American plants found in the study area are a major part of the Willow Springs Paiute's diet. These plants are critical for use in ceremonies as well as in nutrition and medicine. Basket making is one of the major sources of cash for the Willow Springs Paiutes. They make the famous Navajo Wedding Basket, miniature baskets, Paiute-style pitch pine water jugs, and conical burden baskets. Each of these baskets requires plants found in limited supply in the study area.
- *Trails:* Native Americans built and maintained an extensive latticework of trails that serve religious, communication, economic, and political functions and were the sites of many culturally important events. While some trails have been used as the basis for Euroamerican roads, many Indian trails are still largely intact and defined as a significant cultural resource. Information concerning specific portions of Native American trails has been withheld from this report at the request of the Native American consultants. This reasoning is based on the cultural value of the remaining trail sections and the fact that the trail remnants lead to traditional Indian living sites.

Visual Resources

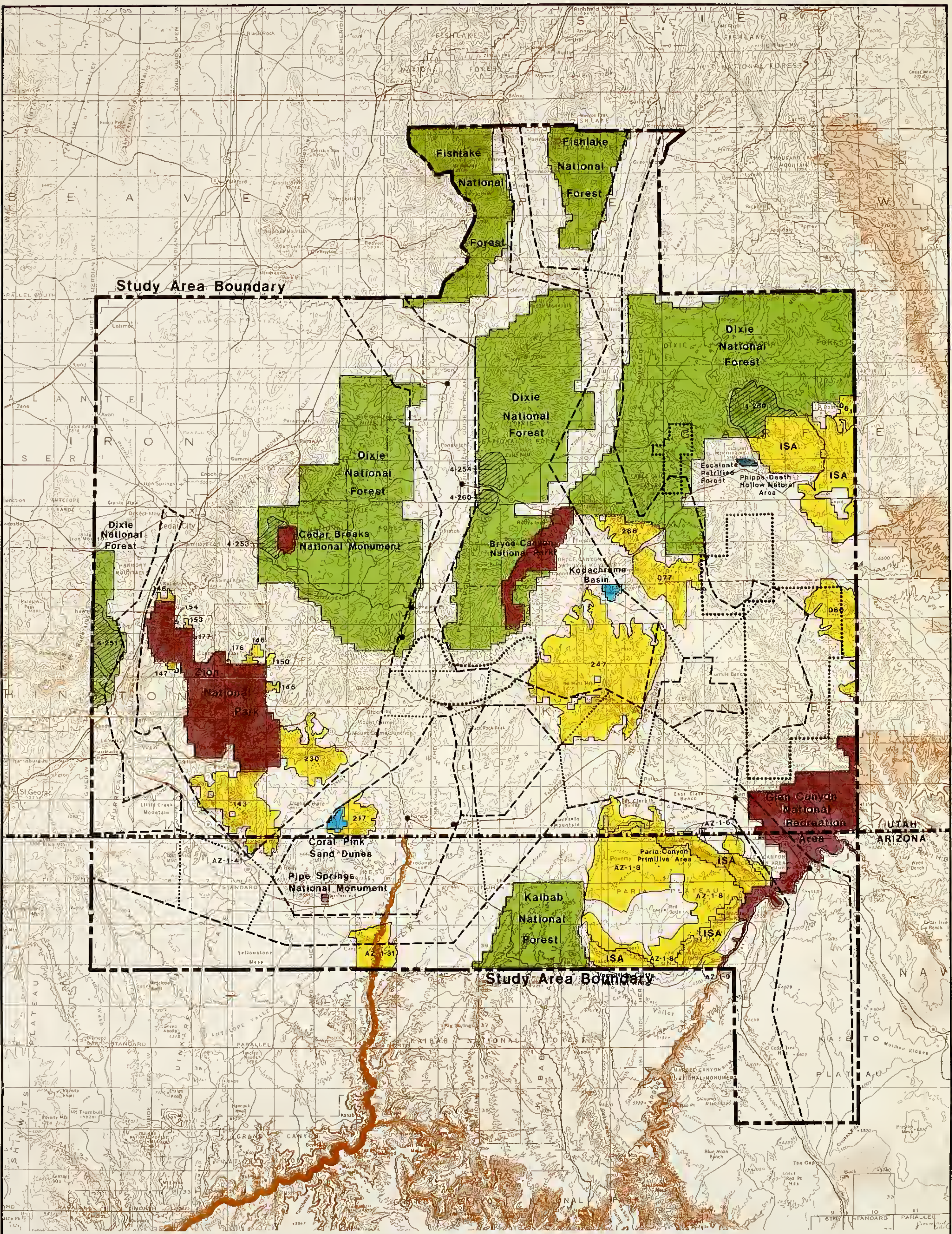
The study area is perhaps one of the esthetically richest, most visually diverse areas in America. Within sight of each other are miles of rolling grassland, precipitous canyons, towering cliffs, volcanic cones, and sand dunes. Textures vary from rocky "badlands" to hayfields, from prime forests to the glassy surface of Lake Powell. The area which is called "Color Country" contains the White Cliffs, Vermillion Cliffs, Pink Cliffs, Coral Pink Sand Dunes, Red Canyon, and Black Rock Peak. It has green pine forests, grey-green sage and, in autumn, irridescent yellow aspen. The area attracts nearly two million visitors a year, many of whom come just to look. The views they seek have been deemed important enough that the area is virtually ringed with national parks and forests. The area's major communities, Cedar City, Kanab, Page, and St. George, depend heavily on the tourism industry to maintain their economic viability.

The large BLM and U.S. Forest Service (USFS) land holdings in the study area have generated standarized evaluation of the area's visual resources that would not otherwise be available. Although the visual resource evaluation procedures of the BLM and the USFS differ somewhat, the objectives of both are to classify visual resources according to their inherent scenic quality, the number of people who will see them, their distance from viewers, and viewer attitudes toward alteration of the landscape. Upon completion of visual evaluation of an area, a composite score is determined by combining the various factors. BLM composite scores, termed management classes, are ranked I through V from highest to lowest. USFS composite scores, termed visual quality objectives, are ranked P-preservation, R-retention, PR-partial retention, M-modification, and MM-maximum modification from highest to lowest. The meanings of ratings for management purposes are defined in Appendix F.

The visual composite score ratings for the planning corridors and mining areas are illustrated on Map 3–7. As shown, there are no Class I areas on BLM lands in the study corridors. However, lands recommended for further study as possible wilderness areas will be managed as if they were Class I visual areas. (See Map 3–8 for locations of proposed wilderness study areas). There are no USFS lands in the study corridors rated P-Preserva-



MAP 3-7. Visual Resource Classes



MAP 3-8.
Recreation Lands and Proposed Wilderness Study Areas

BLM Recommended Wilderness Study Areas (ISA = Instant Study Area)

USFS Wilderness Recommendation & Roadless Further Planning Areas

National Parks, Monuments & Recreation Areas

State Parks & Reserves

National Forests

KEY MAP

UTAH

ARIZONA

10 5 0 10 Miles

10 5 0 10 Kilometers

Note: Numbers refer to BLM proposed Wilderness Study Area and USFS Roadless Area designations.

TABLE 3-10 -Local, regional, and national attractions and use areas within the southern Utah coal region recreation influence zone

Administering agency or ownership	Recreation use area or attraction	Recreation visits or visitor days use (where available)	Major recreation user attractions: Scenery	Pleasure driving	Nature study	Wildlife	Archeology	Works of man	Cultural history	Hunting	Fishing	Swimming	Other water sports	Hiking, backpacking	Camp and picnic	Solitude	4-wheel and ORV	Skiing	Snowmobiling	Other winter sports	Gather resource prods	Other	Comments[1]
Bureau of Land Management:																							
	Virgin River Gorge (1-15)		*	*	*			*							*								Heavy use-interstate highway.
	Cocks Comb		*		*	*	*			*				*	*	*	*						Light use-geological formation.
	Cottonwood Canyon		*	*	*	*	*			*				*	*	*	*						Light use-geological formation.
	Paria Primitive Area		*		*	*	*			*				*	*	*							Light use-spring and fall.
	Paria Townsite		*	*				*	*					*	*								Moderate use-spring/summer/fall.
	Movie Sets	Recreation use records	*	*			*	*	*						*								Moderate use-summer
	Cane Beds	not kept for these	*	*	*									*	*	*	*						Light use-yearlong.
	Coral Pink Sand Dunes	areas, but area	*	*	*	*	*			*				*	*	*	*						Heavy use-off-road vehicle.
	Escalante River	administrators	*		*	*	*							*	*	*							Moderate use-primitive values.
	Calf Creek	estimate accumulative	*	*	*	*	*			*				*	*	*							Heavy use-local; fall and spring.
	Hole in the Rock Trail	use in excess of	*	*	*	*	*	*	*	*				*	*	*	*						Moderate use-historical value.
	Honeymoon Trail	700,000 visits	*		*			*	*					*	*	*							Light use-historical value.
	Hackberry Canyon	annually.	*		*	*	*			*				*	*	*							Light use-natural environment values.
	Phipps-Death Hollow		*		*	*	*			*				*	*	*							Light use-natural environment values.
	Vermillion Cliffs		*	*	*	*				*				*	*	*	*						Light use-spring and fall.
	Dominguez-Escalante Trail		*					*	*					*	*	*							Moderate use-historical values.
	Temple Trail		*					*	*					*	*	*							Moderate use-historical values.
U.S. Forest Service:																							
Dixie National Forest	Pine Valley Mountains	52,800 visitor days.	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*		Heavy use-summer and fall.
	Navajo Lake Area	652,800	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		Heavy use-summer/fall/winter.
	Duck Creek Springs Area	visitor days.	*	*	*	*		*	*	*	*		*	*	*	*	*	*	*	*	*		Heavy use-summer/fall/winter.
	Mammoth Creek Area	296,300 visits to	*	*	*	*				*	*	*	*	*	*	*	*	*	*	*	*		Heavy use-summer.
	Panguitch Lake Area	developed sites	*	*	*	*		*	*	*	*			*	*	*	*	*	*	*	*		Extreme use-summer and fall.
	Brianhead Ski Area	special interest	*	*	*	*		*		*				*	*	*	*	*	*	*	*		Heavy use-winter skiing.
	Cascade Falls Area	areas.	*	*	*	*				*				*	*	*	*		*				Moderate use-summer.
	Lava Beds		*	*	*	*				*				*	*	*							Light use-except viewing.
	Red Canyon	328,800	*	*	*	*				*				*	*	*					*		Heavy use-spring/summer/fall.
	East Fork of Sevier River	visitor days.	*	*	*	*				*	*			*	*	*	*	*	*	*	*		Moderate use-summer.
	Barney Top	80,000 visits to	*	*	*	*				*	*			*	*	*	*	*	*	*	*		Moderate use-summer.
	Griffin Top	special interest	*	*	*	*				*	*			*	*	*	*	*	*	*	*		Moderate use-summer.
		areas and developed																					
		sites.																					
Fishlake National Forest	Beaver Canyon	197,000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		Heavy use-yearlong.
	Puffer Lake	visitor days.	*	*	*	*	*	*		*	*		*	*	*	*	*	*	*	*	*		Heavy use-summer and fall.
	Big Flat		*	*	*	*	*			*				*	*	*	*	*	*	*	*		Heavy use-summer and fall.
Kaibab National Forest	Jacobs Lake	263,000	*	*	*	*	*			*				*	*	*	*	*	*	*	*		Heavy non-resident travel.
	North Kaibab Plateau	visitor days.	*	*	*	*	*			*				*	*	*	*	*	*	*	*		Heavy non-resident and fall
		922,200 visits.																					hunting use.
National Park Service:																							
Pipe Springs Nat'l Mon.	Pipe Springs Nat'l Mon.		*	*	*			*	*						*								Moderate to light visits.
Zion National Park	Zion Nat'l Park	1,090,000	*	*	*	*	*	*	*		*	*		*	*	*							Extreme summer; heavy
		visits.																					spring and fall.
Bryce Canyon Nat'l Park		626,200 visits.	*	*	*	*	*	*	*					*	*	*			*				Heavy use-summer and fall.
Grand Canyon Nat'l Park	North Rim	433,000 visits.	*	*	*	*	*	*	*					*	*	*			*				Extreme use-summer.
Cedar Breaks Nat'l Mon		411,300 visits.	*	*	*	*					*			*	*	*		*	*				Heavy use-summer.
Capitol Reef Nat'l Park	South District	25,000 visits.[3]	*	*	*	*	*							*	*	*	*						Light use.
Glen Canyon Nat'l Rec Area			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*						Heavy use-yearlong.
	Lake Powell (total)	1,061,700	*	*	*	*	*		*	*	*	*	*	*	*	*							Extreme use-spring/summer/fall.
	Carl Hayden Visitor Center	223,300	*					*	*														Extreme use-yearlong.
	Glen Canyon Dam	Not available.	*	*				*	*														Extreme use-yearlong.
	Wahweap Rec Complex	701,300	*	*	*	*		*	*		*	*	*	*	*	*							Extreme use-spring and fall.
																							Heavy summer use.
	Lee's Ferry	95,700 visits.	*	*	*		*	*		*	*	*	*	*	*	*							Heavy use-yearlong.
Navajo Indian Reservation	Monument Valley	Figure not	*	*	*	*	*		*					*	*	*	*						Moderate visits and use.
	Navajo Nat'l Mon. (3)	maintained.	*	*	*		*		*					*	*	*							Moderate visits and use.
	Navajo Bridge		*	*	*			*															Moderate visits and use.
Utah State Division of Parks and Recreation:[2]																							
	Snow Canyon	130,300 visits.	*	*	*	*	*	*	*	*				*	*	*	*						Extreme spring-fall visits.
	Gunlock Reservoir	63,900 visits.	*	*	*	*		*	*	*	*	*	*	*	*	*	*						Heavy yearlong fishing pressures.
	Minersville Reservoir	70,300 visits.	*	*	*	*		*	*	*	*	*	*		*		*						Heavy use-spring/summer/fall.
	Coral Pink Sand Dunes	47,600 visits.	*	*	*	*	*			*				*	*	*	*						Heavy spring-fall ORV use.
	Kodachrome Basin	11,900 visits.	*	*	*	*	*		*	*				*	*	*	*						Moderate to light visits.
	Otter Creek Reservoir	25,500 visits.	*	*	*	*	*		*	*	*	*		*	*	*							Heavy use-spring/summer/fall.
	Escalante Petrified Forest	No statistics.	*	*	*	*	*		*	*				*	*	*	*						Light use-undeveloped.

[1]Light use--generally below environmental and designed carrying capacity.
Moderate use--approaching carrying capacity.
Heavy use--at carrying capacity during most of use period, but above carrying capacity on weekends and holidays.
Extreme use--usually above acceptable carrying capacity for major use facilities and environment areas visited during managed or open season.

[2]Visits are to developed portion at State Parks only. Total visits to attractions being served are not recorded.

[3]Estimated.

Source: U.S.D.I., Geological Survey.
1979. Southern Utah Regional Coal Environmental Statement

TABLE 3-11--Selected developed recreation sites; their capacity, use, and condition for the southern Utah coal region recreation influence zone

Administering agency or ownership	Developed site name and type	Season of use and length of seasons	PAOT[1]	1976[2] recreation visits	1976[3] recreation visitor days use	1976[4] use (percent of capacity)	Comments: Condition and needs at facilities, season of use, intensity of use compared to carrying capacity, etc.
1	2	3	4	5	6	7	8
Bureau of Land Management:							
Dixie Resource Area	Red Cliff rec. site	1/1 to 12/31(365 days)	155	7,200	10,800	30	Good condition; heavy spring and fall use; needs some additional facilities.
Arizona Strip Resource Area	Virgin River rec. site	1/1 to 12/31(365 days)	570	NA[5]	---	---	New site adjacent to Interstate 15.
Vermillion Cliff Resource Area	Ponderosa Grove campground	5/1 to 11/30(214 days)	55	NA	NA	35-40	Satisfactory condition; heavy spring, summer, fall use.
Escalante Resource Area	Calf Creek rec. area	4/1 to 11/30(245 days)	250	15,000	7,000	30-40	Good condition; heavy spring-fall use, moderate summer use.
U.S. Forest Service:							
Dixie National Forest	Pine Valley campground	6/1 to 9/15(107 days)	215	17,500	14,700	32	Moderate summer use; some rehabilitation needed.[6]
	Oak Grove campground	6/1 to 10/15(137 days)	90	10,000	5,600	23	Moderate use; good condition.
	Navajo Lake campground	6/15 to 9/15(93 days)	190	11,500	28,600	81	Extreme summer use; reconstruction and expansion needed.
	Te-Ah campground	6/15 to 9/15(93 days)	210	11,500	28,900	74	Extreme summer use; needs expansion and rehabilitation.
	Panguitch Lake North campground	6/1 to 9/15(107 days)	210	16,500	41,300	92	Extreme summer-fall use; needs expansion and rehabilitation.
	Spruces campground	6/15 to 9/15(93 days)	180	9,500	22,000	66	Very heavy summer use; needs expansion and rehabilitation.
	Duck Creek campground	6/1 to 9/15(107 days)	620	44,000	108,900	82	Extreme summer use; needs expansion and rehabilitation.
	Panguitch Lake South campground	6/1 to 9/15(107 days)	90	9,900	13,000	67	Very heavy summer use; needs expansion and rehabilitation.
	Pine Lake campground	6/15 to 9/15(93 days)	170	---	16,400	52	Heavy summer use; good condition; needs expansion.
	Blue Spruce campground	6/15 to 9/15(93 days)	30	---	4,200	75	Extreme summer use; fair condition; needs expansion and rehabilitation.
	Posy Lake campground	6/15 to 9/15(93 days)	170	---	13,600	43	Moderate to heavy summer use; good condition; expansion needed.
Fishlake National Forest	Little Cottonwood campground	5/15 to 11/15(185 days)	93	35,500	14,000	41	Same as above.
	Little Reservoir campground	6/1 to 10/30(152 days)	67	19,600	9,000	44	Heavy summer use; expansion and rehabilitation needed.
	Kents Lake campground	6/1 to 10/15(137 days)	212	20,300	14,800	25	Moderate summer use; some rehabilitation needed.
	Anderson Meadow campground	6/1 to 9/15(107 days)	50	16,500	6,200	58	Heavy summer use; some rehabilitation and expansion needed.
	Ponderosa picnic area	5/1 to 10/30(183 days)	120	9,700	6,600	31	Moderate summer use; good condition.
Kaibab National Forest	Jacobs Lake campground	5/15 to 11/1(170 days)	240	NA	30,000	80	Extreme summer-fall use; needs expansion and rehabilitation.
	DeMott campground	5/15 to 11/1(170 days)	100	NA	11,000	80	Same as above.
U.S. Park Service.							
Cedar Breaks, New Mex.	Point Supreme campground	6/15 to 9/15(92 days)	100	NA	NA	25-35	Moderate summer use; good condition.
	Point Supreme picnic site	6/15 to 9/15(92 days)	40	NA	NA	25-35	Same as above.
Zion National Park	South campgroud	5/15 to 9/15(108 days)	730	177,400	177,400	35	35 percent yearlong percent of capacity; extreme spring, summer, fall use; needs supplemental campgrounds outside of National Park. 75 percent capacity use in spring, summer and fall.
	Watchman campground	1/1 to 12/31(365 days)	1,175				
Bryce Canyon Nat'l Park	North campground	5/1 to 11/1(214 days)	555	NA	NA	50	Extreme summer use, light in spring and fall; good condition.
	Sunset campground	6/1 to 9/10(102 days)	625	NA	NA	50	Same as above.
Glen Canyon National Recreation Area	Wahweap campground and marina	1/1 to 12/31(365 days)	1,550	701,300	102,900	7	Extreme use; good condition; needs expansion.
	Lee's Ferry	1/1 to 12/31(365 days)	280	95,700	49,800	96	Same as above.
	Carl Hayden visitor center	1/1 to 12/31(365 days)	NA	223,300	NA	NA	Heavy use; parking needs expansion.
North Rim Grand Canyon	North Rim campground	5/1 to 12/30(184 days)	700	205,100	165,100	128	Extreme use; fair condition; needs expansion.
Capitol Reef Nat'l Park	Cedar Mesa campground	1/1 to 12/31(365 days)	32	3,600	NA	31	Moderate use; good condition.
Pipe Springs Nat'l Mon.	---	1/1 to 12/31(365 days)	NA	27,500	NA	NA	Light use; good condition.
State of Utah Parks and Recreation:	Snow Canyon campground	1/1 to 12/31(365 days)	[7]146,000	130,300	NA	89	Facilities good condition; extreme fall and spring use; needs expansion.
	Gunlock Reservoir campground	1/1 to 12/31(365 days)	[7]120,000	63,900	NA	53	Same as above.
	Minersville campground	1/1 to 12/31(365 days)	[7]100,000	70,300	NA	70	Extreme summer, fall use; good condition; needs expansion and traffic control.
	Coral Pink Sand Dunes campground	1/1 to 12/31(365 days)	[7]81,000	47,600	NA	59	Heavy spring and fall use (ORV); needs expansion.
	Kodachrome Basin campground	1/1 to 12/31(365 days)	[7]60,000	11,900	NA	20	Light to moderate use; good condition.
	Otter Creek campground	5/1 to 11/30(214 days)	[7]54,000	25,500	NA	47	Heavy summer use; fair condition; needs expansion and rehabilitation.
	Escalante Petrified Forest campground	1/1 to 12/31(365 days)	undeveloped	NA	NA	---	Needs developed facilities.

[1] Theoretical developed capacity of developed site, expressed in the number of people the site can accomodate at one time (PAOT).
[2] Recreation Visit - one person visiting the site - no time element calculated or involved.
[3] Recreation Visitor Day Use - an aggregate of 12 hours by one or more persons.
[4] Use as a percent of capacity is based on the managed season of use (length of season x PAOT). Well managed sites generally receive between 20 percent and 40 percent use. Beyond 40 percent sites deteriorate rapidly, require heavy maintenance, and user experience levels diminish from overcrowding (i.e., loss of privacy and solitude, increase in noise, disturbances, etc.).
[5] NA - not available or not applicable.
[6] Rehabilitation may include hard-surfacing (paved roads, trails, parking spurs, etc.) of parts of sites to protect soils and vegetation. It may also include installation of traffic control devices (barriers) to prevent ORV encroachment and damage to adjacent soil and vegetation resources.
[7] Yearlong capacities as determined by Utah State Division of Parks and Recreation.

Source: U.S.D.I., Geological Survey.
1979. Southern Utah Regional Coal Environmental Statement

TABLE 3-12
TOTAL ANNUAL VISITOR COUNTS

Year	Arches	Bryce Canyon	Canyon-lands	Capitol Reef	Glen Canyon	Grand Canyon	Zion
1976	294,779	625,597	79,956	425,077	1,009,808	2,791,551	1,222,404
1977	313,383	611,508	75,499	428,819	2,065,986	2,627,152	1,209,648
1978	326,948	679,260	85,932	392,428	2,136,380	2,748,642	1,307,919
1979	269,840	558,095	74,545	288,860	1,655,995	2,131,716	1,145,543

Source: National Park Service

tion and none under consideration for wilderness designation.

Recreation Resources

The study area and surrounding parts of southern Utah and northern Arizona are exceptionally well endowed with recreation resource lands. Within the study area itself are portions of three National Forests, two National Parks, two National Monuments, and a National Recreation Area (see Map 3-8). Within a half-day's drive of the study area, but not shown on Map 3-8, are Canyonlands, Arches, Capitol Reef, and Grand Canyon National Parks; Natural Bridges, Rainbow Bridge, and Navajo National Monuments; the Manti-La Sal National Forest; and Lake Mead National Recreation Area. The area is sometimes described as the "golden circle" of national recreation resources. In addition, the study area contains 3.7 million acres of public lands (BLM), most of which are available for dispersed recreation activities, and several state park and recreation areas (Map 3-8).

The Utah portion of the study area, referred to as "Color Country," is substantially more economically dependent on tourism than any other of the state's nine defined travel promotion regions (Hunt 1976). Kane and Garfield Counties, which comprise the bulk of the study area, are the two most tourism dependent of Utah's 27 counties. Although accurate figures for total tourist visits to the area are not available, recreation visits to selected facilities in 1976 are illustrated in Tables 3-10, 3-11, and 3-12. Table 3-12 shows visitor count trends for several National Park Service (NPS) facilities for 1976 through 1979. Longer term figures for Bryce Canyon National Park demonstrate a 52 percent increase in visitation over the decade from 1969 to 1979. However, individual year-to-year changes in visitation at Bryce vary from a decline of 18 percent (1978 to 1979) to an increase of 41 percent (1974 to 1975).

Despite the vast recreation land resources of the area, developed recreation sites, particularly campsites, are often in short supply. Twenty- five of the 41 developed sites listed on Table 3-11 demonstrate 1976 use rates of at least 40 percent of rated capacity. The U.S. Forest Service (USFS) has found that sites receiving more than 40 percent use "deteriorate rapidly, are difficult to maintain, and are highly subject to vandalism."

Many of the visitors to "Color Country" are drawn by the scenery and opportunities to learn about the cultural heritage and natural history of the area (Utah Division of Parks and Recreation 1976; Stoffle and Last 1980). Thus, most of the major recreation facilities, except for Glen Canyon National Recreation Area, are geared to "passive" use. Dispersed recreation on other public lands in the study area is often more "active", including backpacking, firewood gathering, hunting, and off-road vehicle (ORV) pleasure driving.

As shown on Map 3-8, study corridors coincide with substantial areas of USFS or NPS lands only in C13 around the base of Table Cliff Plateau and in C18 near where the corridor crosses Glen Canyon. The northern portion of the North Kaiparowits coal lease area also is located in the Dixie National Forest.

Wilderness Resources

There are no designated wilderness areas in the study area; however, there are 21 proposed wilderness study areas and three instant study areas on BLM-managed public lands. There are also four parcels of USFS land recommended for wilderness designation and one designated for further planning as possible wilderness. Finally, portions of Bryce Canyon and Zion National Parks, Glen Canyon National Recreation Area, and Cedar Breaks National Monument have received administrative endorsement for wilderness designation. (See Map 3-8)

Instant study areas under the BLM system have previously been identified as having wilderness qualities. Wilderness study areas will be finalized by September 1980. By 1991,

TABLE 3-13

CROPLAND ACREAGE BY COUNTY

County	Cropland (acres)			Percent of Total Land Area	Total Land Area
	Irrigated	Non-Irrigated	Total		
Garfield	31,000	3,000	34,000	1.0%	3,318,400
Iron	50,000	14,000	64,000	3.0%	2,112,000
Kane	11,000	9,000	20,000	0.8%	2,570,240
Piute	27,000	0	27,000	5.6%	482,560
Washington	29,000	22,000	51,000	3.3%	1,553,280
State	1,436,000	783,000	2,219,000	4.2%	57,721,550

Source: Utah Department of Agriculture 1980.

all such areas will be evaluated and final wilderness recommendations will be sent to the President. USFS wilderness recommendations have been made for all but the "further planning" area and currently await Congressional action.

Proposed wilderness study areas are notable considerations in corridor segments C1, C6, C7, C10, C13, C14, and C15 and in the northeast corner of the South Kaiparowits coal lease area. Until and unless such parcels have been officially dropped from consideration, they will be managed such that the land's suitability for preservation as a wilderness area will not be impaired (U.S.D.I., BLM 1979). Right-of-way corridors may be designated in such areas for planning purposes only. No new rights-of-way may be approved except for temporary uses that satisfy nonimpairment standards.

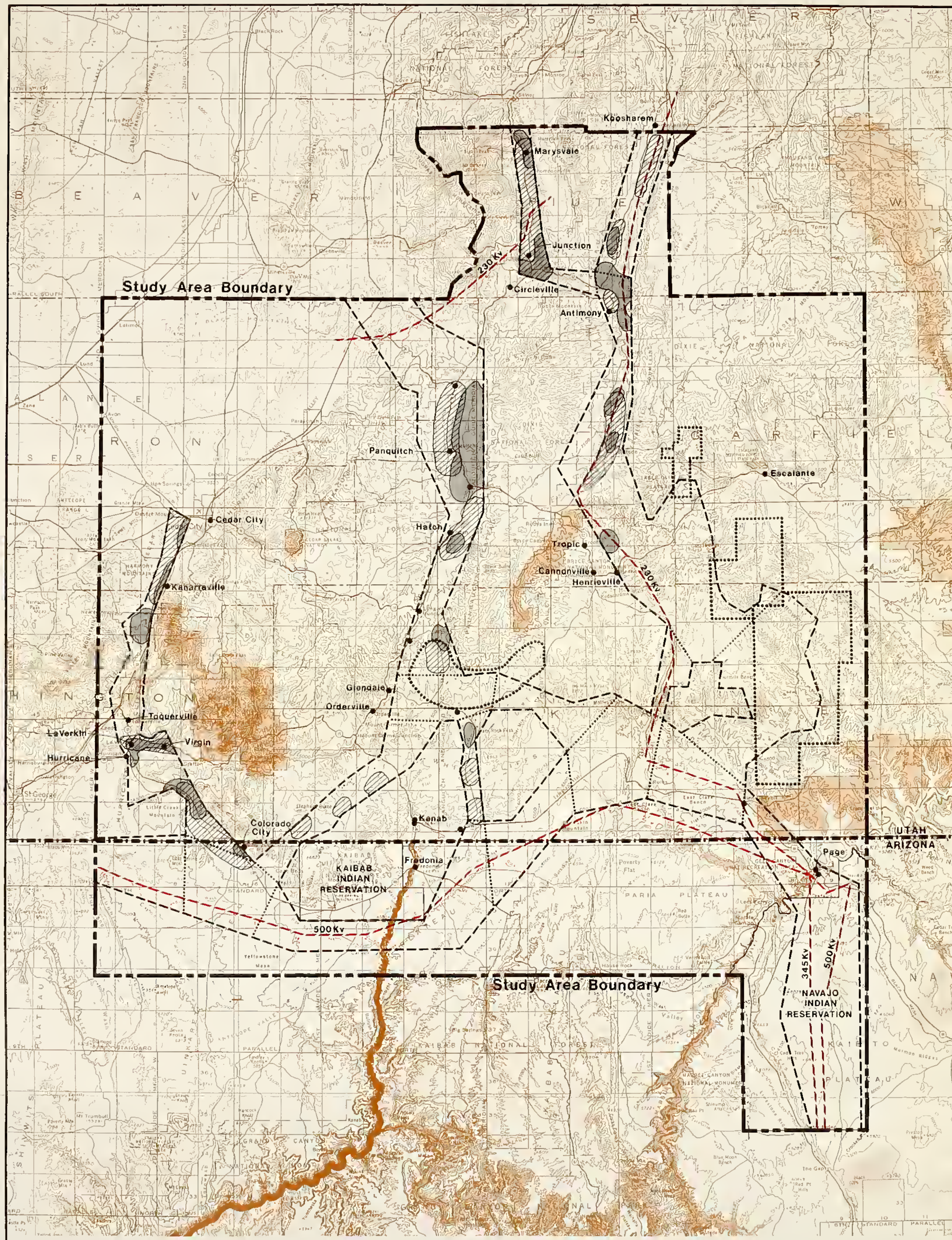
Land Use

The vast landscape of southern Utah and northern Arizona is predominantly rural in character. The study area contains an estimated 11,500 square miles in parts of Garfield, Iron, Kane, Piute and Washington Counties in Utah and Coconino and Mohave Counties in Arizona. The area includes approximately 50 communities ranging in size from fewer than fifty people to approximately 10,680 in Cedar City. The next largest communities after Cedar City are Page, Arizona, at 4,878, Kanab at 3,415, Panquitch at 1,784, Hurricane at 1,734, and Fredonia, Arizona at 1,009. All others are estimated at less than 1,000 (see Socioeconomics discussion for specifics).

A large majority of lands in the study area are publicly owned. The Federal government owns approximately 5.48 million acres (75.5 percent), followed by the State of Utah with 545,000 acres (7.4 percent). Privately owned lands comprise 1.2 million acres, or 16.5% of the total. The remaining 118,000 acres (1.6 percent) are Indian lands. Federal lands are managed under the jurisdiction of three major agencies: the Bureau of Land Management, the Forest Service, and the National Park Service. Included are all or portions of the Fishlake, Dixie, and Kaibab National Forests; Zion and Bryce Canyon National Parks; Glen Canyon National Recreation Area; and Cedar Breaks National Monument. In addition, the Kaibab Indian Reservation is located in the southern part of the study area and a portion of the Navajo Reservation is included in the southeast corner of the study area (see Map 3-9).

Grazing is the most pervasive use of land in the study area both on public and private lands. Federal lands are typically managed to provide for several uses and most National Forest and BLM managed land is available for recreation use and mineral exploration and development in addition to grazing. Ponderosa pine has been extensively harvested for saw timber in parts of the Dixie National Forest and some Engelmann spruce has been taken more recently. Larger areas of both National Forest and BLM land lend themselves to firewood gathering and fence post harvest. Recreation is the predominant use of National Parks, National Monuments, and the Glen Canyon National Recreation Area, although some grazing continues as an artifact of historical use in Zion National Park and the National Recreation Area.

Agricultural crop production is limited to a relatively small portion of the study area. Crop land is found primarily in the valleys in the northwesterly half of the study area where

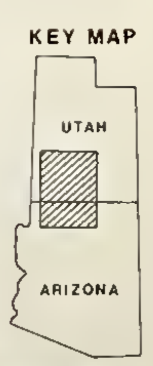


Croplands

Areas Containing Prime Agricultural Lands

Towns Containing Sensitive Land Use (See Table 3-14)

500Kv Existing Transmission Line with Voltage Class



Miles 10 5 0 10

Kilometers 10 5 0 10

MAP 3-9. Sensitive Land Uses and High Voltage Transmission Line Corridors

soils are relatively deep and flat and perennial streams provide a source of irrigation water (see Map 3-9). Larger areas of land are considered arable (see Map 3-2), but the lack of developed irrigation water and unfavorable economics have prevented further agricultural development. Table 3-13 indicates cropland acreages for the five Utah counties touched by the study area. All of the Piute County is within the study area and all major cropland areas in Garfield and Kane Counties are within the study area. Substantial portions of cropland in Iron and Washington Counties are outside the study area. Crop production in the study area focuses on hay and relatively small amounts of small grains used as supplemental and winter cattle feed.

The Arizona strip portion of the study area represents a small portion of Coconino and Mohave Counties, such that county statistics are not indicative of the area. There is very little private land in the Coconino County portion of the study area and most of the public lands are alloted for cattle grazing. A large area south of Colorado City in Mohave County is privately owned but is predominantly grassland rather than cropland.

Communities in the study area utilize substantially less than 1 percent of the land area for residential and supporting urban uses. As described above, Cedar City is the only community in the study area with an "urban" character. Other communities are typically rural residential clusters, many of which contain substantially more agricultural land and land classified as vacant than residential or other "urban" land.

Corridor-specific land use analysis focused on locating existing uses which would have the highest potential of conflict with coal development and transportation activities. Typically, the reason for such conflict would be sensitivity of existing uses to noise, air pollution, traffic congestion, separation of residences from emergency services, or some similar site-specific incompatibility. Existing uses with above average sensitivity to these types of conflicts are primarily residential areas, health care facilities, gathering places such as schools and churches, and public recreation areas. Such areas have been located on Maps 3-8 and 3-9 and enumerated by corridor and by community in Table 3-14. Recreation areas are addressed more thoroughly in the Recreation section.

Two other land use issues of concern in the study area are agricultural crop lands and privately owned lands. Both are in short supply in the study area and conversion of either or both to coal transportation facilities could cause conflicts. In addition to land currently being used for crop production, there are a number of tracts in the study area which contain prime agricultural lands (Hutchings 1980). Map 3-9 generally locates both active croplands and prime agricultural lands, some of which are not currently being used for crop production. Areas defined as prime agricultural lands on the map indicate general areas within which parcels of prime land occur. All lands within the general areas may not be considered prime. Privately owned lands are illustrated on Map 3-10.

Transportation

Roadway System Infrastructure

The existing system of roadways in south-central Utah is oriented towards through traffic movement and access between the few existing population centers. The physical structure of the roadway system is characterized by alignments which have been determined by the topography of the area and the relative location of population centers. North-south traffic in the region is carried by Interstate 15, the only four-lane limited access highway, and U.S. 89, a two-lane at-grade highway (see Map 3-11). State Routes U-9 and U-14 connect Interstate 15 to U.S. 89 and are major east-west routes. Interstate 15 is also linked to U.S. 89A south of Kanab by the combined U-9/U-59/Route 389 roadway alignment.

North of the Alton lease area, State Route U-12 extends from U.S. 89 just south of Panguitch easterly to Escalante and Boulder where the two-lane highway terminates. The only roadway of any significance to the east of the Kaiparowits Plateau is State Route 277 which provides access to Glen Canyon National Recreation Area (NRA) from U.S. 89 at Glen Canyon City. It has 26 feet of road surface and is built on 50-foot right-of-way. Within the NRA, the road narrows and is maintained by Kane County. The National Park Service has indicated that they do not desire improvements to the facility that would allow trucking operations. Most roads on the Plateau are unimproved though some sections are occasionally graded.

Old State Route 136 is a partially asphalted and improved local access road extending from U.S. 89 (segment 89f) approximately 9 miles east of Kanab up Johnson Canyon and north to Alton, traversing the western side of the Alton lease area. Improved county roads also enter the lease area from U.S. 89 (segment 89e) at Glendale on the east and U-12 at Cannonville on the north.

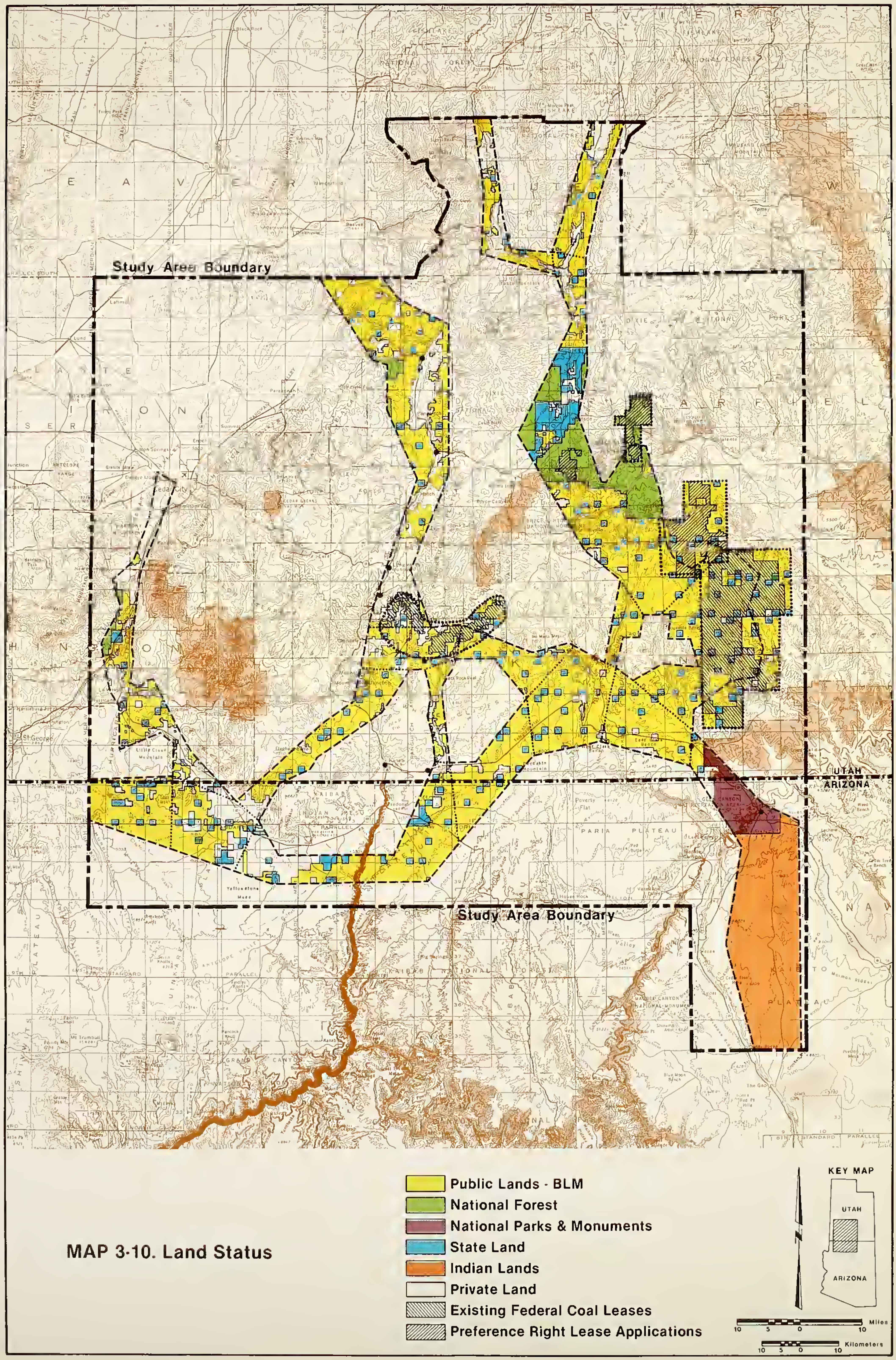
TABLE 3-14
SENSITIVE LAND USES

Corridor/Route Segment	Community	Schools: Nursery	Schools: Elementary & Secondary	Colleges	Churches	Hospitals	Nursing Homes
C1, 14	Cedar City	1	5	1	24	1	1
C1, 389	Colorado City, AZ	-	2	-	1	-	-
C1, 389	Hurricane	-	3	-	4	-	1
C1	Kanarraville	-	-	-	1	-	-
C1	LaVerkin	-	-	-	2	-	-
C1	Toquerville	-	-	-	1	-	-
C1	Virgin	-	-	-	1	-	-
C4, 89c	Hatch	-	-	-	1	-	-
C4, 89b	Panquitch	-	2	-	5	1	-
C9, 89a	Junction	-	1	-	1	-	-
C9, 89a	Marysville	-	1	-	1	-	-
C12	Koosharem	-	1	-	1	-	-
C13	Antimony	-	1	-	1	-	-
C13, 12	Henrieville	-	-	-	1	-	-
C18, 89h, 89i, 98	Page, AZ	-	3	-	?	1	-
12	Cannonville	-	-	-	1	-	-
12	Escalante	-	2	-	-	-	-
12	Tropic	-	1	-	2	-	-
89a	Circleville	-	1	-	2	-	-
89c	Glendale	-	2	-	2	-	-
89e	Orderville	-	see Glendale	-	1	-	-
89e, 89f, 389	Kanab	-	2	-	6	1	-
389	Fredonia, AZ	-	3	-	2	-	-

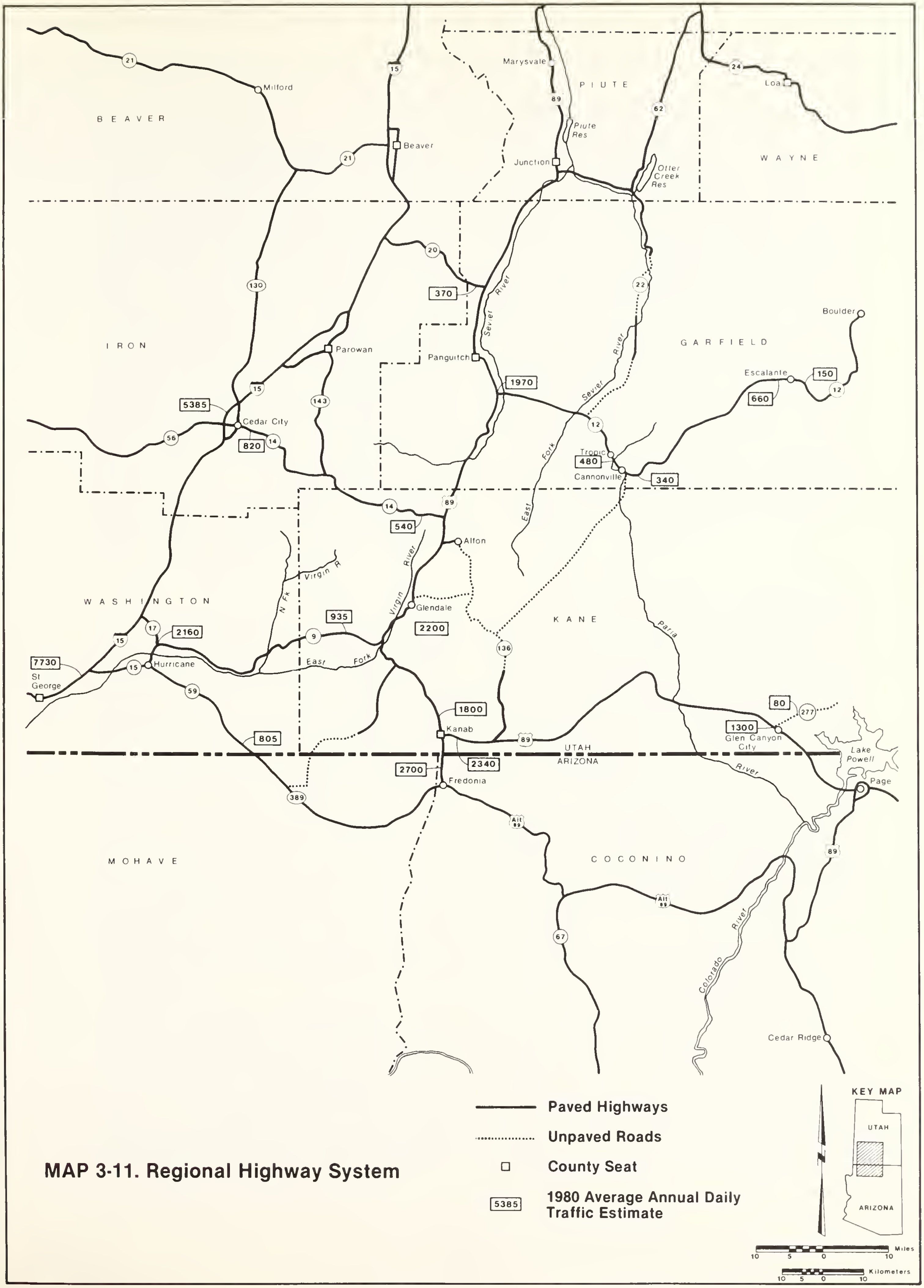
Base-year Traffic Operations

The 1980 average annual daily traffic (AADT) estimates for the area roadways are shown on Map 3-11 (UDOT 1978a). The highest AADT in the region, 7,730, occurs on Interstate 15 by the U-9 interchange. Actual traffic demand on highways in the region may differ significantly on a seasonal basis from the AADT values because of the influx of recreational travel. In terms of local recreational trip attractions, two of the major tourist areas in Utah, Bryce Canyon National Park and Glen Canyon National Recreation Area, are located near the Alton and Kaiparowits lease areas, respectively. In addition to traffic generated by these specific attractions, recreational travel passing through the region also contributes to the seasonal increase in traffic. The cumulative impact of recreational trip activity is illustrated by the monthly variations in traffic demand shown in Table G-1 in Appendix G. The highest month of trip activity in southcentral Utah is July. For U.S. 89, traffic flow during July averaged around 60 percent higher than the AADT values. The only local route in the study area with a permanent count station, U-14, has a July traffic demand 116 percent greater than the AADT value. Because of marked peaking characteristics of traffic demand due to recreational travel, the summer months represent the most severe test on the roadway system.

In addition to the level of demand, the composition of the traffic is one of the prevailing conditions on which the quality of roadway operations is dependent. As shown in Table G-2 in Appendix G, heavy trucks (vehicles with six or more tires) currently comprise between 12.7 and 15.7 percent of the total vehicle flow on U.S. 89 near the Alton and Kaiparowits lease areas. The importance of recreation travel is also reinforced by the large percent of out-of-state passenger vehicles on area roadways.



MAP 3-10. Land Status



MAP 3-11. Regional Highway System

Traffic Flow Analysis

The capacity of a highway is a measure of its ability to accommodate traffic and is a function of physical geometries such as number of lanes, lane width and grade, magnitude and composition of demand volumes, and operating speeds. The results of the roadway capacity analyses are summarized in Table G-3 in Appendix G. Even under maximum July recreational peak demand conditions, all of the roadway facilities with the exception of segment 89e, are operating at the Level of Service B standard (UDOT assigned) or better. Segment 89e has a low assigned service volume B standard because of the long steep vertical grades and the sharp horizontal curvature. On the east-west segment of U.S. 89, the highest volume/capacity ratio of 0.75 occurs east of Kanab on segment 89f. U-9, which serves as a connection between Interstate 15 and U.S. 89, has the highest computed ratio for local roadways. The results of the capacity analyses indicate that the existing traffic operations in the study are generally in a stable flow range.

Geometric Design Consideration

The rural highways serving the Kaiparowits region have certain key geometric design characteristics that have operational significance for traffic movement. Specific criteria include pavement construction and horizontal and vertical curvature. The majority of the two-lane highways in the Kaiparowits region were constructed to carry light to moderate traffic demand. The roadway segments that are an exception to this condition are 89f and 89g between Kanab and Glen Canyon City. This portion of U.S. 89 has been resurfaced with a 3- to 4-inch pavement overlay within the last four years. Based on field inspection, the overlay appears to be holding up well under the existing levels of coal hauling truck activity between Salina and Page, Arizona. U.S. 89 heading north from Kanab needs to be upgraded by a pavement overlay treatment since the existing pavement on the highway is starting to deteriorate.

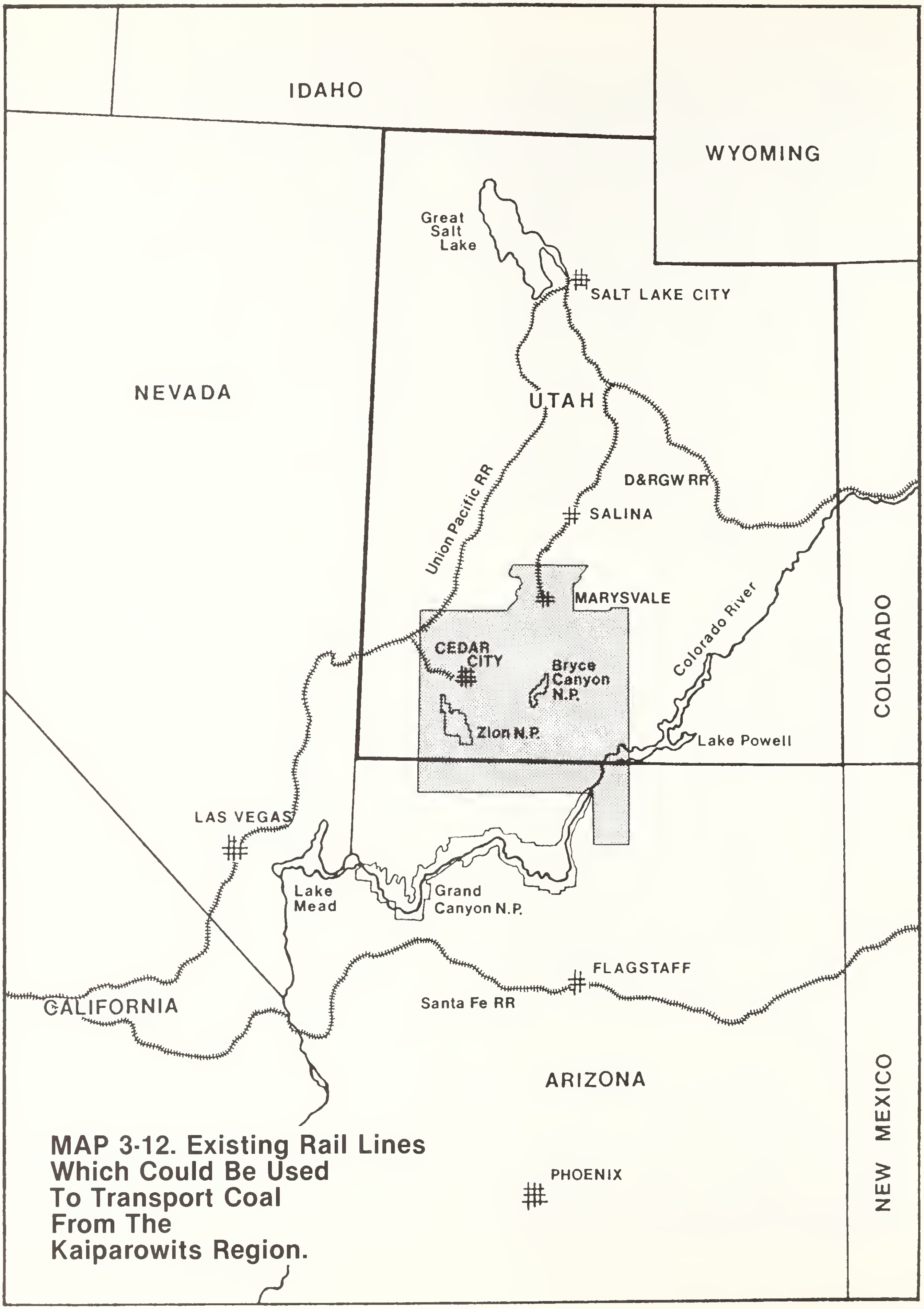
Physical design considerations on the westerly segment of U-12 include the steep vertical grade from Tropic to the Bryce Canyon access road and the two natural rock formation tunnels in the Red Canyon area. UDOT has been working with the National Park Service on a feasibility study for providing a climbing lane on the vertical grade for trucks. The two tunnels have sufficient clearance for standard size trucks, but are not adequate for oversize loads. From Bryce Canyon east to Escalante the roadway is characterized by narrow lane widths, areas of pavement deterioration, long steep vertical grades, and horizontal curvature problems. A major operational consideration on U-12 during the summer months is the tourist use of the roadway to access Bryce Canyon National Park and natural areas around Escalante. Tourists frequently park along the side of the road to view the natural features of the area. The parked vehicles present problems to the existing logging and crude oil truck activity on the road.

Winter weather conditions are a major roadway operational consideration in the south-central Utah region. U-14 is frequently closed during winter months because of snow accumulation. During the spring thaw, U-14 has a 20,000-pound load limit because of extremely wet sub-base conditions. Many of the gravel and dirt roads traversing the Alton and Kaiparowits fields are closed from November to May because of snow and wet conditions.

Railroads

The Kaiparowits Plateau region has no rail service at the present time. The nearest railroad lines terminate to the north and west of the coal lease areas (see Map 3-12). To the north, the Denver & Rio Grande Western Railroad enters from Colorado, passes through Price, and continues to Salt Lake City. From this main line, a spur line extends southward through Richfield to Marysvale. The Marysvale spur is classified as a B Branch Line of a Class I railroad in the Utah State Rail Plan (UDOT 1978c). B Branch lines are identified as light density lines carrying less than 1 million gross tons per year. The section of spur line between Richfield and Marysvale has been identified as a potential problem area for economic viability (UDOT 1978c), while the section between Salina and Marysvale could not sustain coal unit train traffic without being rebuilt.

West of the Kaiparowits region, a Union Pacific Railroad main- line passes southwestward from Salt Lake City on its way to Las Vegas. A branch line extends from Lund to Cedar City. The Cedar City rail connection is classified as an A Branch Line of a Class I railroad. A Branch Lines are defined as carrying less than 5 million gross tons, but at least 1 million gross tons per year. South of the region, the Atchison, Topeka, & Santa Fe Railroad crosses east to west through central Arizona and Flagstaff. No railroad bridges cross the Colorado River in northern Arizona.



MAP 3-12. Existing Rail Lines Which Could Be Used To Transport Coal From The Kaiparowits Region.

TABLE 3-15
POPULATION OF THE SOUTHWEST UTAH REGION BY COUNTY

County	Annual growth rate of population, 1950-70 (in percent)	Annual growth rate of population, 1970-75 (in percent)	1950	1960	1970	1975
Beaver	-1.2	+1.3	4,856	4,331	3,800	4,086
Garfield	-1.4	+0.8	4,151	3,577	3,156	3,300
Iron	+1.2	+3.4	9,642	10,795	12,177	14,609
Kane	+0.3	+6.3	2,299	2,667	2,421	3,384
Washington	+1.7	+5.3	9,836	10,271	13,669	18,127
Region Total	+0.7	+3.9	30,784	31,641	35,224	43,506
Utah	+2.2	+2.4	688,862	890,627	1,059,273	1,207,000

Sources: U.S. Bureau of the Census, Census of Population, 1950-1970, *Utah: Number of Inhabitants* (Washington, D.C.: U.S. Government Printing Office). U.S. Bureau of the Census, Current Population Reports, *Population Estimates and Projections,* series p-25, no. 692 (Washington, D.C.: U.S. Government Printing Office, April, 1977).

Socioeconomics

The geographic base for discussion of socioeonomic issues throughout this report will vary somewhat from the boundaries of the study area used for other disciplines due to limitations of available data. Much of the socioeconomics discussion will focus on Kane and Garfield Counties for two reasons: the two counties comprise the bulk of the study area and a large majority of the population of the two counties resides within the study area such that county-wide socioeconomic impacts would largely be impacts on the defined study area. Other portions of the socioeconomics discussion will address the entire five-county, southwestern Utah planning region comprised of Beaver, Garfield, Iron, Kane, and Washington Counties, because the socioeconomic data base is more complete for the region than for individual counties. Finally, when possible and appropriate, Piute County and the "Arizona Strip" portions of the study area are addressed. These areas are covered less thoroughly because very little data were provided for them in the Socioeconomics Technical Report (Five County 1980) and because identified impacts are generally less extreme in these segments of the study area.

Historic and current estimated population in the study area is illustrated in Table 3-15 and Appendix K. As shown, the population is quite small for such a large land area. The population density of Kane and Garfield Counties is approximately 1.8 persons per square mile compared with 3.0 per square mile for the five-county southwestern Utah region, and approximately 70 per square mile for the entire United States. Recent growth in the area has resulted from dramatic increase in tourism and growing recognition of the area as an attractive retirement location.

The pattern of settlement in the study area is typically small residential clusters in agricultural areas reflecting the historic communal nature of Mormon agricultural settlements. These small communities are addressed extensively as the loci of socioeconomic and community impacts in the Socioeconomics Technical Report and in Chapter IV.

The economy of the study area is represented here by employment statistics. Economic sectors providing the most jobs in the southwest Utah region are agriculture, manufacturing, government, trade, and services (see Table 3-16). When compared with employment distributions for the State of Utah as a whole and for the United States, the agriculture sector in southwest Utah is

TABLE 3-16
CIVILIAN LABOR FORCE AND NONAGRICULTURAL JOBS IN THE SOUTHWESTERN DISTRICT FIRST QUARTER 1979 AND 1980

	District Total				Garfield County				Kane County			
	1980 Persons	1980 % of Employed	Persons 1979	1979-80 Percent Change	1980[1] Persons	1980[1] % of Employed	Persons 1979	1979-80 Percent Change	1980[1] Persons	1980[1] % of Employed	Persons 1979	1979-80 Percent Change
Civilian Labor Force	20,979		20,014	4.8	1,600		1,569	2.0	1,255		1,199	4.7
Employed	19,621	100.0	18,822	4.2	1,359	100.0	1,301	4.5	1,130	100.0	1,090	3.7
Unemployed	1,359		1,192	14.0	241		268	-10.1	124		110	12.7
Percent of Labor Force	6.5%		6.0%		15.1%		17.1%		9.9%			9.2%
Percent of Labor Force Seasonally Adjusted	5.4%		4.9%		8.9%		10.1%		5.3%		4.9%	
Total Nonagricultural Jobs	15,629	79.7	14,902	4.9	1,197	88.1	1,136	5.4	822	72.7	789	4.2
Mining	533	2.7	516	3.3	151	11.1	146	3.4	10	0.9	10	0.0
Contract Construction	900	4.6	869	3.6	11	0.8	11	0.0	8	0.7	8	0.0
Manufacturing	1,497	7.6	1,434	4.4	246	18.1	225	9.3	70	6.2	70	0.0
Durable Goods	702		632	11.1	213		192	10.9	2		2	0.0
Nondurable Goods	794		802	-1.0	33		33	0.0	68		68	0.0
Trans., Comm., & Pub. Util.	1,013	5.2	950	6.6	70	5.2	66	6.1	83	7.3	78	6.4
Trade	4,267	21.7	4,062	5.1	127	9.3	122	4.1	209	18.5	200	4.5
Wholesale Trade	521		474	9.9	0		0	0.0	16		15	6.7
Retail Trade	3,746		3,589	4.4	127		121	5.0	193		185	4.3
Fin., Insur., & Real Estate	711	3.6	670	6.1	19	1.4	18	5.6	38	3.4	36	5.6
Service	2,139	10.9	1,967	8.7	180	13.2	166	8.4	112	9.9	103	8.7
Government	4,569	23.3	4,435	3.0	392	28.8	383	2.4	292	25.8	284	2.8
Federal Government	589		595	-1.0	80		81	-1.2	23		23	0.0
State Government	1,417		1,351	4.9	54		51	5.9	46		46	0.0
Local Government	2,563		2,489	3.0	258		250	3.2	223		216	3.2
Agricultural Jobs[2]	1,500	7.6			150	11.0			120	10.6		

Source: Utah Department of Employment Security
[1]preliminary
[2]Estimated; no coincident figures provided.

relatively more important as is the government sector (particularly state and local government). Manufacturing and services sectors, though numerically important, are much less important, percentage-wise, to southwest Utah than to the state or nation. The employment patterns for Kane and Garfield Counties (Table 3-16) indicate that both are highly dependent on agriculture and government relative to the state, the nation, and even the five-county southwest region.

Other key economic considerations are the very small size of the labor force and employment bases of Kane and Garfield Counties, the two smallest of the five counties in the region, and the fact that tourism, which is very important to the region, does not show up as a separate sector. Tourism has been estimated to provide 58 percent and 34 percent, respectively, of the Kane and Garfield County economies, making them the two most tourism-dependent counties in the state.

Unemployment rates in the southwest Utah region and particularly in Kane and Garfield Counties have consistently been higher than state and national figures. The gap has been less in recent years, but, as illustrated in Table 3-16, the Garfield County seasonally adjusted unemployment rate remains quite high. Despite the relatively high rate, the available labor force is quite small as dictated by the small total labor force. Estimated total personal income for counties in the study area is illustrated in Table 3-17.

Community facilities and services in the study area are typically very rural in nature

TABLE 3-17
TOTAL PERSONAL INCOME IN SOUTHWESTERN COUNTIES RESIDENCE ADJUSTED (THOUSANDS OF DOLLARS)

	1950	1959	1965	1970	1971	1972	1973	1974	1975
Utah	$911,500	$1,675,400	$2,368,800	$3,439,462	$3,760,483	$4,216,337	$4,814,051	$5,349,770	$5,954,381
Southwestern Counties									
Beaver	5,900	6,000	8,300	10,384	11,821	13,067	15,669	17,409	18,197
Garfield	3,800	5,400	5,900	7,551	8,664	9,585	10,685	11,156	12,281
Iron	10,300	18,600	25,100	33,599	38,567	43,023	49,824	55,155	61,359
Kane	2,400	4,600	4,600	6,478	7,611	9,268	10,363	10,828	11,698
Washington	8,300	15,500	21,500	34,911	38,203	44,400	53,843	58,667	66,139

Source: 1970-75, U.S. Department of Commerce, Bureau of Economic Analysis, *Local Area Personal Income 1970-1975*, vol. 8; 1950, 1959, 1965; Bureau of Economic Analysis Tapes.

which is in keeping with the small cluster, low density population. Kane and Garfield Counties typically provide educational facilities spotted as necessary in the towns of the study area. Each county has one hospital, located in Kanab for Kane County and in Panguitch for Garfield County, and one or more satellite clinics. Other major, county-provided services are general government services such as clerk and recorder, the county sheriff for law enforcement, and solid waste management and disposal for many of the counties' communities. Both counties have very minor involvement in recreation facilities and both subsidize the state library system to a small degree, though neither operates a library. Both counties also provide road maintenance on county roads.

Towns in the study area are typically very small with the exception of Panguitch and Kanab in Utah, and Page in Arizona. Services provided by most towns are limited to domestic water service; fire protection, usually staffed by volunteers; street maintenance; some form of police protection, often a cooperative arrangement with the county sheriff; and local recreation facilities. Wastewater is typically handled by individual septic systems except in Kanab, Tropic, and Page. General government is provided as appropriate to administer the various communities. Current services are generally considered adequate or plans are under way to improve them to the desired standards for existing populations. See Socioeconomics Technical Report prepared by the Five-County Association of Governments (Five-County 1980) for further details.

Socio-Cultural Aspects

A brief overview of the history of the region is required to describe adequately the important socio-cultural aspects of the area that would be impacted by coal development on the Kaiparowits Plateau and the alternative scenarios examined to transport the coal from the area. The area of Utah and northern Arizona that would be impacted was settled largely by early Mormon pioneers who were sent by Brigham Young to colonize new communities. Young's ambitious expansionist policy envisioned the creation of the Territory of Deseret as a self-sufficient political entity not dependent upon the United States or any other country. What is now southwestern Utah was especially important to this policy because of the discovery of important coal and iron deposits and the extended growing season which allowed the harvesting of cotton and other warm weather crops.

Settlement patterns in the area were similar to those established in other early Mormon communities. Rural villages were created and each family was given a lot for homes and barns. Farms and ranches were then located in the countryside surrounding the community. This pattern permitted collective activity and political organization much earlier than did the isolated homestead pattern. It also contributed to the close integration of political and church organizations, and it is still often the case in these communities that local church leaders are also elected or appointed political leaders.

Following their initial settlement, most of the communities grew in population as farming and ranching became more established. However, beginning about four decades ago, many of the communities began to experience a significant out-migration as younger people, particularly, were forced to move elsewhere in search of educational and employment opportunities. Some reversals in these trends have been noted in the larger communities of St.

George and Cedar City, but in the smaller isolated communities, the pattern has been one of stagnation or decline. The recent national emphasis on the development of domestic energy has resulted in significant activity throughout the study area and has led to the return movement of some families. However, most growth to this point has occurred in the larger communities and has been related to retirement and recreation development in Washington and Kane Counties and to Cedar City's emergence as a major service and trade center.

Low population densities and geographical isolation make it difficult for local communities in the area to provide adequate community services for their populations. Many families must travel 50 or more miles to receive medical or dental care. Shopping and recreational opportunities are very limited and the usual pattern is to make larger purchases in communities like Cedar City, St. George, and Richfield on a periodic basis.

Local values in the study area emphasize the importance of the family. Families tend to be significantly larger than the national average and many activities are jointly organized around the family and the church. Educational attainment has been valued historically and has contributed to significant out-migration from the area. Delinquency and crime tend not to be significant problems because of the value systems of area residents and because of the effective operation of informal social control exercised by the community and the church. The local political ideology strongly emphasizes local control, resulting in increasing conflict with representatives of other levels of government, particularly those charged with managing the public lands in the area.

Appendix H presents the methodology used to collect data for the socio-cultural baseline description and subsequent impact analysis. The attitudes of a clear majority of residents of the study area strongly favor economic growth, development, and the exploitation of local resources. The most overwhelmingly favorable attitudes in this regard are found in the more sparsely populated Kane and Garfield Counties and in the smaller rural towns throughout the area that have been characterized by population decline. Developments which would enhance local economic opportunities and which would result in sufficient growth to justify the establishment of new services such as medical services, better shopping, and more cultural opportunities would be welcomed. In addition, such growth is perceived as allowing young people to remain in the area rather than migrate elsewhere. However, a majority of residents would not favor growth at a rate and magnitude that would significantly change the existing lifestyle or characteristics of local communities. They fear that boom growth would overwhelm important local institutions and would seriously impair the ability of the local communities to provide the necessary services (including schools, police protection, housing, and medical care) that would be required by a rapidly growing population.

The communities in the study area tend to be characterized by a relatively high degree of integration and cohesion. Local populations are highly homogeneous in terms of the ethnicity, religious affiliation, and cultural values and traditions. Because of this, outsiders often have difficulty in being fully integrated into the communities, though this varies significantly from one area to another. There is also a good deal of variation in terms of the preparation and ability of the communities to deal with growth and change. One tends to find a great deal of opposition to regulation by any outside agency. Accordingly, many of the communities have no zoning regulations or community master plans. A growing number of local leaders recognize this condition as eventually leading to important problems if growth from energy development does occur.

Noise

The remote location and the low population density of the study area are primarily responsible for the absence of noise pollution. Most of the study area is located away from cities, major highways, and factories and thus has very low ambient noise levels. This noise is very near the ambient level in nature without man or machines. The only areas where ambient noise levels rise above this low level are along major highways and near cities, farmed lands, and mechanized recreation areas such as Coral Pink Sand Dunes (ORVs) and Lake Powell (power boats).

Natural noise sources consist of wind, rain, thunder, insects, birds, and other wildlife. Noise measurements taken in remote areas have shown that noise levels in natural environments can be extremely low, on the order of 15 decibels (dBA). These levels vary over a considerable range, up to 45 dBA, depending upon what natural sources are present (EPA 1971).

Typically, a maximum permissible outdoor sound level near a hospital or church would be 55 dBA during the day and 45 dBA at night. The U.S. Department of Housing and Urban Development (1971) has classified sources ex-

ceeding 65 dBA for a total of less than 8 hours per 24 hours as normally acceptable.

Areas of Critical Environmental Concern

An Area of Critical Environmental Concern (ACEC) is an area within the public lands where special management attention is required to protect and prevent irreparable damage to important resources or to protect life and safety from natural hazards. The Federal Land Policy and Management Act of 1976 specifies that the identification of ACECs shall be given priority in the inventory of public lands but that identification shall not, of itself, affect the management or use of those lands. Designation of ACECs is a formal BLM process that would be analyzed and carried out as part of BLM's Resource Management Plans. The decision to designate an ACEC is made by a BLM District Manager and describes the special management attention required. Analysis performed for the Kaiparowits Coal Development and Transportation Study may serve as groundwork for the ACEC process.

The ACEC process consists of two parts, identification and designation. The identification step precedes and is separate from the designation step. Four identification criteria must be met for further consideration for ACEC designation. All four criteria—Relevance, Importance, Criticalness, and Protectability—must be met in every case. Detailed definitions of these criteria as well as further discussion of the ACEC process is presented in BLM Guidelines (1979). Within the Kaiparowits region there are many environmentally sensitive areas that may warrant further consideration as potential ACECs. Many such areas were reviewed early on in the development of constraints used in delineating the coal transportation corridors presented in Chapter 2.

ACEC guidelines (BLM 1979) specify "relevance" to include areas of historic value, cultural value, scenic value, fish or wildlife resource, natural system or process, or natural hazard. In addition, an environmental resource must be "important" and so have qualities which give it more-than-local significance and special worth, consequence, meaning, distinctiveness, or cause for concern compared to like entities. These resource areas must also be considered to be "critical". This would occur if the qualities that make it important are being subjected to decisive adverse change unless special management attention is applied. Resource areas within the coal lease areas and transportation corridors would necessarily qualify for this criteria. Finally, an environmental resource involved must be capable of being "protected". Protectability can be influenced by an area's size, location of its boundary, physiography, and committed uses nearby or otherwise affecting the area.

These criteria were applied to the environmental elements within the coal lease areas and transportation corridors. Results of evaluations provide several areas which are recommended for further consideration as potential ACECs. These include areas of historic value, specifically those presented in the Archaeology Section and found on Map 3-6 as sites included on or nominated to the National Register of Historic Places. Other areas of cultural significance, especially those known to have a high density of archaeological sites are also shown of Map 3-6 and on backup material provided to BLM. Areas with significantly high scenic values relative to the whole of scenic southern Utah are largely already designated and protected by the National Park Service in the form of National Parks and National Monuments. Further protection of scenic areas is not envisioned at this time. Significant fish and wildlife resources are described in that section and presented on Map 3-5. Of special concern are the habitats of several endangered species. Habitats of endangered fishes in the Virgin River may require consideration as ACEC. Bald eagle wintering areas may be too large to protect as an ACEC (Map 3-5), but populations of the Utah prairie dog appear to qualify for consideration. Critical winter range for mule deer and other big game species would require further study to be eligible for identification as an ACEC. Natural systems should include consideration of locations of rare plants listed as endangered or proposed as candidate species as possible ACECs. Locations of such areas are depicted on Map 3-4.

FUTURE ENVIRONMENT WITHOUT COAL DEVELOPMENT

The following section discusses how conditions in the study area would change over the next 40 years (1980 to 2020) without development of coal reserves. Only those environmental elements which would undergo significant changes will be discussed.

The populations of counties in the study area have grown since 1970 at rates ranging from 2.1 percent per year (Garfield County) to 5.7 percent per year (Washington County). If the potential coal development activity in south-central Utah does not occur, then the

TABLE 3-18 BASELINE POPULATION PROJECTIONS

County	1970	1980	1990	2000
Garfield	3,157	4,889	6,888	7,616
Kane	2,421	4,511	6,774	8,764
TOTAL	5,578	9,400	13,662	16,380

region's population is expected to increase at a low rate under a normal growth pattern. The major economic base for the region would continue to be agriculture and tourism along with supporting government and service sector activity. Baseline population projections, assuming no intensive coal development, for Garfield and Kane Counties are shown in Table 3-18.

No significant changes in the ambient regional air quality of the study area would be expected without coal development. However, a decrease in the visible range of up to 50 percent could be expected between 1980 and 2001. This decrease would result from particulate emissions generated by the increased populations of the urban areas in the region. In addition, emissions from the Warner Valley Power Plant would affect the vista from Lava Point south to Mt. Trumbull.

Soils and vegetation would be disturbed by anticipated growth, some soil would be lost by wind and water erosion, and land use would change from natural or agricultural crop production to community use. Better management of sheep and cattle grazing has helped to increase the amount and quality of vegetation over the last thirty years. This trend is expected to continue into the future. The present trend toward fewer sheep numbers and a leveling-off or slight upswing in cattle numbers should continue over the next several years. The archaeological and paleontological resources of the study area may be affected by the population increase which might result in more people looking for artifacts and fossils. Use of water would increase with the population, probably at the expense of agricultural use.

Projected population increases would create additional pressure on wildlife in the study area. Some encroachment on mule deer, upland game, and mountain lion ranges would result from urbanization and from development of homes in rural recreational subdivisions. Some areas would be irreversibly committed to an urban environment, with the loss of wildlife that are intolerant of man's activities and an increase in species adaptable to urbanization. The direct loss of wildlife from illegal shooting, highway mortality, and other activities would increase. Range improvements, water developments, and better management practices would increase habitat and carrying capacities of some wildlife. Planned transplants of game and nongame species would increase the range of some species and introduce new ones into the area.

No major changes to visual resources are anticipated without development of coal in the study area. It is expected that some number of the numerous proposed BLM wilderness study areas would eventually be designated wilderness areas which would change the visual class rating to Class I for those areas and greatly restrict activities that could degrade the visual environment.

Tourism and recreation demand would be expected to continue to grow although the rate of increase would likely decline if gasoline prices continue to rise. The projected doubling of population by the year 2000 would increase the locally based demand for developed recreation facilities. At the same time, some increase in developed facilities would be expected, due in part to the State Division of Parks and Recreation's priority emphasis on Color Country tourism (Utah Division of Parks and Recreation 1976). However, the increase in the number of facilities cannot be quantified. Enjoyment of scenic resources, especially long distance views, would be impaired to some extent by the projected 50 percent reduction in visual range (see the Visibility Section). In addition, the visual range reduction at the vista from Lava Point south to Mt. Trumbull could affect tourism.

Most of the population growth in the study area is expected to locate in or near existing communities. Kane and Garfield Counties, for example, officially encourage development within existing communities in their Master Plans. In addition, the larger communities are typically expected to attract somewhat more than proportional shares of the overall growth. Most communities in the study area have am-

TABLE 3-19
SOUTHWEST UTAH REGION EMPLOYMENT PROJECTIONS BASELINE

Industry	1980	1985	1990	1995	2000
Agriculture	1466	1107	862	690	567
Mining	590	778	829	898	989
Contract Construction	1192	1370	1362	1383	1533
Manufacturing	1505	1812	2124	2478	2900
Transport Communication & Util.	982	1177	1360	1579	1859
Wholesale & Retail Trade	4684	6051	7357	8826	10588
Finance-Insurance-Real Estate	635	886	1108	1375	1727
Services	2807	3431	3830	4237	4769
Government	4116	5146	5736	6030	6393
Non-Farm Proprietors	1822	2078	2242	2390	2571
Total	19,798	23,837	26,811	29,886	33,897

ple land within their existing boundaries to accommodate expected growth without coal development through the year 2000. The only potentially significant land use conflict which would be expected to occur without coal development would be the conversion of some agricultural land to residential use in communities surrounded by croplands. With the amount of vacant land available in most communities, little conversion of cropland would be necessary to accommodate this "baseline" growth. Only Kanab and Panguitch are projected to need significant acreage beyond their present boundaries.

A population increase of the magnitude projected would result in only a minor increase in traffic flow on regional highways. The Utah Department of Transportation has forecast only a slight increase in regional traffic demand (UDOT 1980). This increase is attributable to growth in agriculture and tourism in the region. The projected traffic increases are not of a scale that would require major physical improvements to the highway system, and no new rail line construction would be required. Without intensive development of the region's coal resources, no major changes in the region's transportation needs are expected.

Projected population growth without coal development is illustrated in Table 3-18 and Appendix K. Projected changes in the size and sector distribution of employment in the southwest Utah region are illustrated in Table 3-19. As shown, manufacturing and trade are major gainers; agriculture is the major declining sector.

Future community facilities and services characteristics have been itemized in terms of community fiscal impacts. Both Kane and Garfield Counties project the need for major capital expansion of hospital facilities. The small towns of the study area typically project no major captail needs. Page, Kanab, and Panguitch project capital needs for schools. Page and Kanab will also need library and recreation expansion and Page will need a new fire station. Panguitch projects expansion of general government offices and major construction of a wastewater treatment plant.

County operating expenses are projected to decline slightly, on a per capita basis, as county populations grow. Community per capita operating expenses, on the other hand, would be expected to remain constant for all communities except Panguitch and Henrieville under baseline conditions. Panguitch and Henrieville would pass population thresholds in 1983 and 1990, respectively, which would indicate higher levels of community services would be required. See Socioeconomics Technical Report (Five-County 1980) for details.

Assuming current tax and fee rates would continue, per capita revenues for both counties and communities are projected to decline slightly with increased population. This would occur because some revenue sources increase automatically and in proportion to increases in population. Others increase indirectly or partially while the population grows, and still other revenue sources do not change at all with changes in population. The net result is that expenditures are projected to exceed revenues slightly for all counties and communities under baseline growth conditions (Five-County 1980). Small tax increases would be required to maintain current service levels.

CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

The Environmental Consequences chapter is divided into three main sections. The first section describes the assumptions and analysis guidelines used in the study. Detailed impact analysis for the coal transportation modes (truck haulage, railroads, and slurry pipelines) is presented in the second section. The third section describes overall impacts associated with coal development. Significant impacts have been presented and, where appropriate, additional supportive information has been placed in the Appendix.

Impact analysis for the Kaiparowits Coal Development and Transportation Study concentrated on the expected impacts resulting from three potential levels of coal production on the three coal lease areas and from three different modes of coal transportation off these lease areas. Topics for discussion were limited to those resource elements which would be significantly affected by coal development. This follows the philosophy of the new Council on Environmental Quality's (CEQ) National Environmental Policy Act (NEPA) guidelines. Most physical impacts would be restricted to the coal lease areas, transportation corridors, and truck haul routes. Therefore, descriptive information and impact analysis were limited to these areas. However, certain resources such as air quality and visibility, visual resources, transportation, socioeconomics, and recreation required analysis over a broader area due to the regional nature of potential impacts.

ASSUMPTIONS AND ANALYSIS GUIDELINES

To the extent possible, development activities, baseline conditions, and the analysis of expected impacts were based on the Southern Utah Regional Coal Environmental Impact Statement, documents collected for the annotated bibliography, and discussions with local experts. However, since this was a regional planning study lacking a well-defined proposed action, it was necessary to develop many assumptions on which to base impact analysis. Even with these assumptions, it was not possible to quantify many potential impacts or describe the significance of impacts as is done for most environmental impact statements (EISs). The refined scenarios, the coal transportation corridors and truck haul routes, and the assumptions presented below were used to define the potential development activities which were analyzed. The following assumptions are grouped according to their sources to help the reader understand the development of the set of assumptions used in the Kaiparowits study.

Applicable Assumptions from the Southern Utah Regional Coal EIS

(With Modifications and Additions)

The assumptions below were taken from or used in the preparation of the Southern Utah Regional Coal EIS. They were used to assure comparability between the Kaiparowits study and the earlier Southern Region EIS. However, ERT has modified or expanded some of these assumptions with the concurrence of the Steering Committee.

1. Annual water consumption will be at the rate of the 1 acre-foot for each four persons (225 gallons/day); for each acre-foot used, one half will be returned to the system downstream.

2. Sewage treatment plants are or will be made adequate so that raw sewage will not be discharged. (State and Federal standards would be met)

3. Sewage effluent will not be recycled for domestic use.

4. Community development will be at the rate of 8 persons per acre. This is an average figure for total acreage, including streets and other public rights-of-way, public facilities, and commercial and industrial lands, in addition to residential areas (U.S. EPA 1979).

5. Lands converted to housing will not be returned to other uses.

6. Mining will be conducted so as to yield maximum recovery of the coal deposits consistent with protection and use of other natural resources, sound economic practice, and protection of the environment. Recoverable reserves are estimated to be 50 percent of inplace reserves where underground mining methods are to be used, 94 percent of in-place reserves where surfaced mined.

7. Mining will average 15 tons per man-shift of underground mining and 75 tons per man-shift for surface mining. (The underground mining rate for Utah in 1976 was 12.1 tons per man-shift.)

8. Longwall mining methods will be used where technically and economically feasible.

9. Mining and reclamation technology will not change significantly with methods remaining essentially the same as at present.

10. Labor and equipment shortages will not significantly distort the projected levels of development.

11. Induced traffic on a given segment of highway will be predicted based on the historic relationship between population and traffic for that segment. Estimated increases in recreation traffic will be based on attraction relationships.

12. With the exception of mine access and haul roads, future traffic will be accommodated on the existing and presently proposed highway system.

13. In estimating commuting traffic, it is assumed that all employees will commute by motor vehicle, and that the vehicles will contain an average of 1.3 persons each.

14. It is assumed that the average fuel efficiency of autos and light trucks would improve by 50 percent between 1975 and 1990.

15. For computational purposes, it is assumed that coal-haul trucks will have a net load capacity of 25 tons (gross vehicle weight of 80,000 pounds).

16. Incidental service truck traffic to mines is estimated to be 20 visits per day per million tons per year production. For the study, incidental truck traffic is assumed to be in the heavy truck category (six wheels and over).

17. It is assumed that access roads to individual installations maintained by private means would have a 22-foot traveled way with 5-foot shoulders, ditches on both sides, and cut and fill slopes of 2 to 1 where this configuration can be achieved. Private roads are assumed to have a graveled surface where average daily traffic is less than 500 vehicles per day and a stabilized or asphalt surface at average daily traffic volumes above this amount.

    Public roads are assumed to meet American Association of State Highway Officials standards and to have a 24-foot traveled way and an asphalt surface as a minimum. The basic public road configuration is assumed to be upgraded as needed to accommodate anticipated traffic, including such features as heavy-duty surfacing, passing lanes, reduced grades, and acceleration lanes at major intersections.

18. Power line rights-of-way are assumed to be 50 feet wide for transmission lines of 69kv or less, 120 feet wide for 138kv and above. Clearing of vegetation would be kept to the minimum.

19. A lower economic limit for construction of a railroad primarily to haul coal by unit train is assumed to be 30 million tons per year.

20. A modern railroad from any main line track to the Kaiparowits Plateau is assumed to have centralized train control.

21. Railroad capacities are assumed to be:

    a. Single-track railroad, 2.5 mile-long sidings spaced 11 miles apart: up to 25 trains daily.
    b. Double-track 10 miles in 40: 50 to 55 trains daily.
    c. 50 percent double-track: 60 to 70 trains daily.
    d. 100 percent double-track: 75 to 125 trains daily.

22. Union Pacific Railroad (*Southern Utah Rail Study*, UPRR Co., 1977) anticipates that trains along a Kaiparowits railroad spurline would consist of "not more than" 100 100-ton coal cars and 5 to 6 diesel locomotives, assuming main track limiting grades of 1 percent westbound and 1.6 percent eastbound.

23. Using an 8,500-ton unit train, an upper limit for single-track railroad would be about 40 million tons of coal per year. If it becomes necessary to double-track 10 miles out of each 40, the track could carry 75 to 90 million tons per year.

BLM Assumptions (With Modifications)

The following assumptions were developed by the BLM for the original Request For Proposal (RFP) to limit the scope of the analysis and give specific direction to the content of the study. These assumptions were also modified as the study progressed.

1. Technical feasibility shall be considered only insofar as necessary to determine reasonable physical limitations for any one transportation mode. To be noted is that mixed modes of transportation may be used in practice at one time among the various leaseholders transporting coal from different mines to different destinations by different routes.

2. The low level of coal production for each or all geographic coal lease group(s) is the maximum amount which could be expected to be transported by truck only. This would assume that all leases (including Preference Right Lease Applications (PRLAs) within each coal lease group would not meet diligent development requirements.

3. The medium level of coal production for each or all geographic coal lease groups is the minimum amount necessary to ammortize a railroad or slurry pipeline. In addition, the diligent development requirements set forth in 43 CFR 3400 (Fed. Reg. Vol. 44, No. 54, March 19, 1979, p. 168,000, et. seq.) may or may not be met.

4. The high level of coal production for any or all geographical coal lease groups would assume diligent development occurring or being exceeded for all existing leases and PRLAs (both Federal and state) within each geographic coal lease group and may or may not include other scattered, existing state leases.

5. Except for the Warner Valley and Navajo Power Plants, all coal would be transported out of the study area rather than being used within the Kaiparowits region.

ERT Assumptions

The following assumptions were developed by ERT to facilitate impact analysis and were reviewed and approved by the Steering Committee.

General

1. Surface Mining

    Area disturbed, mine:
        40 acres/million tons per year (MTY)

    Area disturbed, plant:
        200 acres/mine (1/lease area)

    Water usage, mine and plant:
        135 acre-feet/MTY

    Mine production year - 260 days

    Miner work year - 230 days

    Alton - main access road:
        55 miles (includes mine haul roads but not upgraded county roads)
        power line right-of-way (ROW): 50 miles

    North Kaiparowits - main access road:
        10 miles

        power line ROW: 25 miles

        All surface mining in north section of lease area.

2. Underground Mining

Coal production: 1.5 MTY/portal

Area disturbed, processing plants and loadouts:

Low level - 100 acres

Medium level, North Kaiparowits - 1,000 acres
South Kaiparowits - 3,000 acres

High level, North Kaiparowits - 2,000 acres
South Kaiparowits - 4,000 acres

Water usage, mine and plant: 232 acre-feet/MTY

Limestone usage, mine: 5,730 tons/MTY

Mine production year and miner work year - same as for surface mining

South Kaiparowits - main access road: 30 miles
power line ROW: 35 miles

North Kaiparowits - main access road: 20 miles
power line ROW: 20 miles

3. SUMMARY OF SURFACE DISTURBANCE FROM COAL MINING (in acres)

	Alton			North Kaiparowits			South Kaiparowits		
	Low	Medium +	High	Low	Medium	High	Low	Medium	High
Mine pit[1] for mine life	3,200	7,740[2]			3,200	4,800			
Box cut	25	100			25	50			
Mine portals		150		25	250	500	50	500	750
Plant and loadout									
surface	100	200			100	200			
underground				100	1,000	2,000	100	3,000	4,000
Access roads									
surface	150	667					121		121
underground				242	242	242	364	364	364
Power line ROW[3]									
surface	303	727					152		152
underground				121	291	291	212	509	509
TOTAL[4]	3,778	9,584		488	5,381	8,356	726	4,373	5,623

[1]Based on 40 acres disturbed/million tons of coal produced.
[2]Based on a 23-year total surface mine life. Phase-out begins in year 21.
[3]Assumes 69kv for production up to 3 MTY and 138kv for over 3 MTY.
[4]Based on a 40-year mine life.

4. SUMMARY OF WATER USE FROM COAL MINING, TRANSPORTATION, AND INDUCED POPULATION
(Acre-feet/year in the year 2000)

Water Use[1]	Alton			North Kaiparowits			South Kaiparowits		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Surface Mining	270	1,215	1,215		270	405			
Underground Mining				206	2,678	5,562	412	6,180	9,270
Coal Slurry Pipeline		7,101[2]	7,101		11,835				
TOTAL	270	8,316	8,316	206	14,783	5,967	412	6,180	9,270

[1]Domestic water use resulting from coal development at the low, medium, and high levels would be 2,431, 15,919, and 25,355 acre-feet/year, respectively.
[2]Based on 789 acre-feet of water used to transport each million tons of coal.
Note: 1 acre-foot/year = 893 gallons/day

Air Quality/Visibility

5. For the medium and high production levels, a new town would be constructed on East Clark Bench just west of Glen Canyon City. This town would occupy 3,900 acres.

6. Engineering, design, and construction practices are assumed to comply with local, state, Federal, or professional standards.

7. For the air quality/visibility analysis, coal transfer points within the study area are assumed to be the following (see Map 2-1):

   Alton - low, medium, and high levels - Bald Knoll

   North Kaiparowits
   North section - truck loading for medium level, 1 mile north of Cabin Creek Mine. Conveyor to train transfer for high level, center of southern boundary of section.

   South section - low, medium, and high levels - 2 miles northeast of Camp Springs.

   South Kaiparowits -low level - northeast of North Branch Creek at Bench Mark 5640. Medium and high levels - as above, plus west of Last Chance Creek on Four Mile Bench near Bench Mark 6120.

   Cedar City - truck to rail

   Navajo Power Plant -truck to coal pile

   Warner Valley Power Plant -truck to coal pile

8. Specific transporation route assumptions for air quality regional modeling:

   Low Production - Truck Haulage

   Alton to Warner Valley Power Plant

   North Kaiparowits to Milford

   South Kaiparowits to Cedar City

   Medium Level

   Alton (slurry pipeline) to west side of study area via Corridor Segments C6 and C2

   North Kaiparowits (slurry pipeline) to north side of study area via Corridor Segment C12

   South Kaiparowits (railroad) to Milford via Corridor Segments C17 and C16

   High Level

   Alton (slurry pipeline), as medium level

   North Kaiparowits (railroad) to Salina

   South Kaiparowits (railroad), as medium level

9. For the air quality/visibility and transportation analysis, coal production and rail transportation are assumed to take place at a constant rate, 24

hours/day, 5 days/week. Truck transportation of coal is assumed to take place 16 hours/day, 6 a.m. to 10 p.m. It is also assumed that 15 percent of the work force for any mine would be management and office personnel working a single 8 a.m. to 5 p.m. shift.

10. For the air quality/visibility and transportation analysis, the average speed for haul trucks and unit trains is assumed to be 40 miles per hour.

11. The average daily round-trip commuting distance is assumed to be 100 miles.

12. For total suspended particulate (TSP) emissions, the following haul road lengths within the coal lease areas are assumed.
    Alton - 12 miles

    North Kaiparowits (north) - 10 miles

    North Kaiparowits (south) - 12 miles

    South Kaiparowits -20 miles

13. For TSP emission, open areas at the plant sites are assumed to be 25 percent of the total disturbed area or 100 acres, whichever is larger.

14. Of the total TSP emissions, 30 percent by weight is assumed to be under 3 microns in size.

Water Resources

15. Water for coal production and transportation is assumed to come from the following sources:

    Alton, mining and slurry pipeline -groundwater

    North Kaiparowits

    north section, mining - groundwater

    south section, mining and slurry pipeline - groundwater or Lake Powell

    South Kaiparowits mining and slurry pipeline - Lake Powell

    It is assumed that the water rights necessary to utilize these sources could be acquired.

16. For groundwater modeling a transmissivity value (t) of 10,000 gallons/day/foot, a storage coefficient of 0.12, and a minimum well spacing of 2,000 feet were used.

Biological

17. Assumptions for quantifying biologial impacts (USDI, BLM 1978)

Region	Carrying Capacity of Occupied Habitat	Productivities Per Acre-Year
Uinta-Southwestern Utah	8.3 acres/animal unit	Sagebrush steppe, 1.8 tons
	4-6 small mammals/acre	Mountain hardwood, 5.8 tons
	1 mule deer/100 acres	Montane evergreen forest, 8.0 tons
	1 elk/100 acres	Corn, 95.8 bushels
	2.5 songbirds/acre	Hay, 2.5 tons
	1 gamebird/5 acres	Wheat, 23.3 bushels
	1 large predator/500 acres	Sugarbeets, 17.8 tons
	2.6 reptiles-amphibians/acre	
	55 pounds trout/acre-foot stream	
	250 pounds fish/acre-foot reservoir	

18. Slurry pipelines would be placed below the scour line of stream channels or would be suspended above canyons and draws.

19. Slurry pipeline breaks are assumed to occur at the same rate as other liquid pipelines, specifically 0.0012 breaks/mile/year (ICC 1974).

20. Time required to reclaim mined land (USDI, BLM 1978):

    Rangeland - 13.4 years
    Cropland - 12.3 years

Transportation

21. Truck Haulage

    Haul road ROW width: 100 feet (would accommodate two-way haul truck traffic)

22. Coal Slurry Pipeline
    ROW width: 75 feet (could accomodate two parallel lines)

23. Railroad

    ROW width: 200 feet (could accomodate sidings, dual tracks, and most cut and fills)

    Rock ballast required for the construction of a railroad would amount to 7,000 tons of rock per mile. Because of wastage in a materials pit, which could be as high as 25 percent, the amount to be quarried would be 8,800 tons for each mile of track.

24. Coal produced by surface mining at the north section of the North Kaiparowits lease area during the medium and high level scenarios would be transported to a loadout facility in the following manner:

    Medium - truck haulage to a slurry plant located in the south section of the lease area south of Escalante, approximately 26 miles.

    High - conveyor transport to rail loadout located at the southern boundary of the north section, approximately 5 miles.

25. Assumptions for worst-case transportation analysis

Maximum Tonnage (MTY) for Truck Haul Route Segments

Segment	Maximum Tonnage	Worst-Case Average Hourly Truck Volumes
12	1	20
14	4	77
89a	3	58
89b	3	58
89c	2	40
89d	4	77
89e	2	40
89f	4	77
89g	4	77
89h	4	77
89i	2	40
98	4	77
136a	2	40
136b	2	40
389	4	77

Maximum Tonnage for Rail Haul Routes

Destination	Maximum Tonnage	
	Medium Production Level	High Production Level
Salina	45 (42 trains/day)	75 (70 trains/day)
Milford	54 (50 trains/day)	84 (78 trains/day)
Cedar City	45 (42 trains/day)	75 (70 trains/day)
Flagstaff	45 (42 trains/day)	75 (70 trains/day)

TABLE 4-1
SUMMARY COMPARISON OF COAL TRANSPORTATION IMPACTS

Truck Haulage	Coal Slurry Pipeline	Railroads
	Air Quality	
Emissions from coal trucks would not violate any Federal or state air quality standards. However, projected traffic volumes at Bryce Canyon (Class I) and Kanab (Class II) are within 10% of the limiting values for TSP. No truck-related standards violations anticipated from any other pollutant.	No emissions are projected from operation of coal slurry pipelines. Emissions from pipeline construction activities would not violate any Federal or state air quality standards for any pollutant.	Rail emission would require TSP mitigation in all scenarios to achieve Class II PSD increments, and in the high scenario to achieve NAAQS on the S. Kaiparowits-Milford line. Available-cost effective mitigation would alleviate all potential violations except the are PSD Class I increment near Bryce Canyon, which would be borderline for TSP and SO2 for the high high scenario only. No train-related standards violations are anticipated for any other pollutants.
	Visibility	
No visibility impacts attributable to truck transportation are projected.	No significant visibility impacts are anticipated. Construction dust plumes would occasionally be visible in corridors during initial construction period. During highest year construction, dust loading would be <1% of existing county totals.	Same as "coal slurry" except highest year regional dust loading would be 3-5% of existing totals by county.
	Topography and Geology	
No effect	Minor alternations, if any, to topography.	Cut and fill operations would alter topography. Significance of impact would be dependent upon location of rail line. Would require ballast for railroad bed (9,000 tons/mile).
	Soils	
No effect.	Impacts would result from mechanical handling and mixing of the topsoil, loss of topsoil to erosion, loss of topsoil through mixing with subsoil, and compaction of topsoil by construction equipment.	Same as coal slurry but to a greater extent.
	Water Resources	
No effect	Construction of coal slurry lines would result in temporary increases in runoff and sediment. Potential pipeline rupture would effect water quality in stream receiving the discharge. Water supply impacts would be significant and are summarized in Table 3 of the summary.	Construction of railroad would result in temporary increases in runoff and sediment.
	Vegetation	
No effect.	Area losses resulting from construction of coal slurry lines in corridors would be insignificant when compared with regional vegetation composition. However, adverse impacts to candidate and listed threatened or endangered species could result. Corridor segments C-13, C-14, and C-15 have a high potential for conflict with candidate and listed species. If a site-specific alignment does not avoid these species, the construction of the slurry line would have a significant impact on the candidate and listed threatened or endangered species.	Same as coal slurry but area disturbance and impacts would be expected to be slightly greater.
	Wildlife	
Increased truck traffic would result in an increase of deer mortality by 82 deer per year.	Loss of wildlife habitat would reduce carrying capacity of the region as a whole. Streams crossed during construction would be temporarily impacted due to increased sedimentation. Potential slurry line breaks could indirectly impact aquatic ecosystems.	Loss of wildlife habitat would reduce carrying capacity of the region as a whole. Streams crossed during construction would be impacted due to temporary increased sedimentation. Additional wildlife loss would be associated with train collisions.
	Paleontological Resources	
No effect.	Direct impacts from construction and indirect impacts from amateur collectors.	Direct impacts from construction and indirect impacts from amateur collectors. Greater chance for disturbance due to wider right-of-way.
	Archaeological Resources	
No effect.	Zero to 7 cultural resource sites for corridor segment would be disturbed by construction of coal slurry pipeline.	Two to 18 cultural resource sites for each each corridor segment would be disturbed by construction of railroads.

TABLE 4-1
SUMMARY COMPARISON OF COAL TRANSPORTATION IMPACTS—Continued

Truck Haulage	Coal Slurry Pipeline	Railroads
	Native American Concerns	
No effect.	Direct impacts from construction and indirect impacts from amateur collectors and vandalism.	Direct impacts from construction and indirect impacts from amateur. Collectors and vandalism. Greater chance for disturbance due to wider right-of-way.
	Visual Resources	
Increased traffic would reduce aesthetic enjoyment of visual environment.	Construction of a coal slurry pipeline would result in visual degradation. With standard reclamation efforts, slurry pipelines could be accommodated in BLM VRM Class III and IV areas and in USFS M and MM areas. However, there would be a greater difficulty in meeting standards of higher visual class areas. Corridor segments C1, C6, C13, C14, C15, and C-18 contain Class II or R areas that would be impacted if pipelines were constructed.	Same as coal slurry but visual degradation would be greater because of substantial cut and fill areas in rough or steep terrain. BLM VRM Class IV contrast criteria could generally be satisfied. Meeting Class III or higher standards would typically require mitigating design treatment. Corridor segments C1, C6, C13, C14, C15, or C-18 contain Class II or R visual areas that would be impacted if railroad were constructed.
	Recreation	
Significant conflicts with recreation traffic would occur on all major truck routes.	Minor conflicts during the construction period would occur where the pipeline would cross major recreation travel routes.	Conflicts with recreation traffic would occur where rail lines cross recreation travel routes.
	Land Use	
Trucks would generate noise near sensitive land uses. Increased traffic would effect certain land use activities (i.e., recreation, agricultural) in all route segments except 20 and 98.	Land use would be impacted by the following: • Construction noise on sensitive uses. • Disruption of surface R-O-W during construction (one-season loss of • cropland production). • Disruption of cropland due to potential pipe rupture and spillage.	Potential land use impacts due to railroad development include the following: • Construction noise on sensitive uses. • Operating noise on sensitive uses. • Transportation impacts on land use. uses from railroad R-O-W. • Preclusion of other uses from railroad R-0-W.
	Transportation	
On a daily basis 462 coal trucks would be generated from the lease areas. The increase in coal trucks would (1) accelerate deterioration of the pavement surface in various areas (2) increase potential of accidents th automobiles (3) affect sensitive land uses (4) increase number of livestock killed in areas of open range and (5) reduce operating speeds.	Increased traffic from construction workers and supply trucks. Traffic disruption during construction of road crossings.	Increased traffic from construction workers and supply trucks. Traffic disruptions during construction of road crossings. Vehicle delays at rail crossings. Increased train-auto accident potential.
	Socioeconomics	
See Table 3 in Summary for combined impacts.	Population would be signficantly increased in in Hurricane, Kanab, Escalante and the Greenwich/Koosharem area for the construction period. Other socioeconomic impacts were not analyzed independent of coal development. See Table 3 in Summary for combined impacts	Population would be signficantly increased in several communities for the 2 to 4 year construction period. New heavy construction jobs would be provided as follows: North Kaiparowits to Marysville, 990 jobs for 2 years; South Kaiparowits to Page, 825 jobs for 2 years; South Kaiparowits to Milford, 1045 jobs for 4 years; and South Kaiparowits to Cedar City, 1100 jobs for 4 years. See Table 3 in Summary for other socioeconomic impacts.
	Sociocultural	
No significant effect.	Small communities in Kane, Garfield, Piute and Washington Counities would experience significant impacts due to inability of population growth and lifestyle differences of newcomers.	Railroad construction would significantly impact the sociocultural environment of small communities in Kane, Garfield, Beaver, Iron and Piute Counties of Utah and Fredonia, Arizona due to lifestyle differences and inability of public services to accommodate population increases.
	Noise	
Maximum sound level at roadside of 90 dBA. Maximum permissible night-time noise levels for hospital zones (45 dBA) could be exceeded under worst-case conditions.	No significant effect.	Maximum sound level 50 feet from trucks of 90 dBA. Maximum permissible night-time noise levels for hospital zones (45 dBA) could be exceeded under worst-case conditions.

TABLE 4-2
CORRIDOR SEGMENTS IN WHICH SIGNIFICANT ENVIRONMENTAL EFFECTS COULD OCCUR

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18
Air Quality[1]					X					X			X					
Visibility[1]					X					X			X					
Topography	X	X		X	X				X	X			X	X	X		X	
Soils	X			X	X			X	X	X	X	X	X	X	X	X	X	
Water Resources[2]				X				X										
Vegetation									X					X		X		
Wildlife[1]				X					X				X			X		
Paleontology	X	X	X	X		X	X	X					X	X	X			
Archaeology	X			X	X	X	X	X		X				X	X	X	X	X
Native Americans								X										X
Visual[1]	X					X		X	X	X			X	X	X			X
Recreation					X					X			X					X
Wilderness										X			X	X	X			
Land Use	X			X				X	X			X	X					X
Transportation[1]	X	X		X	X		X		X	X			X	X	X		X	X
Socioeconomics				X					X				X					X
Socio-Cultural				X					X				X					X
Noise[1]	X			X					X			X	X					X

Source: ERT Project Team
[1] Includes operational effects of railroads
[2] Includes operational effects of coal slurry pipelines

26. For the purposes of this study *truck haul routes* are defined as those segments of the Federal, state, and county highway system which would be utilized to haul coal from the lease areas to destinations inside or outside of the study area. *Access roads* are those roads which would be constructed to connect loadout and administrative facilities within the lease areas to the main highway system. *Haul roads* are those roads which would be constructed within the lease areas to connect the mine pits or portals with the coal processing and loadout facilities.

COAL TRANSPORTATION IMPACTS

Overview

This section discusses the impacts of truck haulage, railroads, and coal slurry pipelines on all haul routes and in all appropriate corridor segments. Only those environmental elements which would be impacted are discussed. An overview of construction and operation impacts associated with different modes of coal transportation in the corridors is presented. Impact analysis has been completed by truck haul segments (16 segments) and for each of 18 corridor segments. An attempt has been made to identify specific impacts and to compare impacts for various types of transportation modes (i.e., coal slurry and railroad). However, in many cases it has not been possible to provide specific comparisons for various modes within each segment, because there is no specific proposal to evaluate and each mode would follow a different alignment within the corridor.

The impacts from the construction and operation of coal slurry pipelines and railroads have been discussed in a single section, because the impacts from linear facilities are quite similar. However, it should be noted that the impacts from the construction and operation of a railroad would be greater in magnitude due to the larger size of the facilities. For example, a railroad would require a 200-foot wide right-of-way (24 acres/mile) while a coal slurry pipeline would require only a 75-foot wide right-of-way (9 acres/mile). Wherever possible, the differences in impacts between these two transportation modes have been discussed; however, exact quantification of certain impacts (i.e., surface disturbance) will have to await site-specific right-of-way proposals.

In order to provide appropriate information to decision-makers and future coal transportation applicants, the coal transportation impacts are presented in a manner which does allow for some general comparisons among

transportation modes. These are summarized in Table 4-1. While such comparisons may be general, they are important in understanding the impacts associated with different modes of transportation in the study area. In addition, this section also indicates critical environmental features or values within each corridor segment that should be avoided by transportation projects. Table 4-2 summarizes potential significant effects by environmental element and corridor segment. This information will assist coal transportation applicants in the selection of specific alignments.

Truck Haulage Along Haul Routes

Insignificant or minor impacts were noted for the following environmental elements; topography, geology, minerals, vegetation, soils, water resources, paleontological resources, archaeological resources, Native American concerns, visual resources, wilderness, and sociocultural.

Air Quality and Visibility

Air quality impacts resulting from transportation were individually evaluated for nineteen separate locations in the study area. Modeling was performed for both annual and hourly averaging periods for particulates (deposition incorporated) and gases (no deposition). The annual assessment utilized, measured, and interpolated terrain- adjusted stability array wind roses as the defining meteorology. The hour average evaluations used worst-case hour terrain-specific meteorology. The assumptions and methodology used in the transportation modeling are fully described in the Air Quality Technical Report (ERT 1980).

Particulate matter is the most significant truck-related emission. Engine particulate emissions from trucks constitute less than 1 percent of the mitigated blow-off emissions from the stabilized coal cargo. The coal blow-off emissions are primarily heavier, larger particulates and therefore remain near the roads, whereas the gases and exhaust particulates remain aloft and are transported across the region. Truck engines emit slightly more than two times as much gaseous pollutant per ton of coal hauled than do the locomotives. The modeling indicates that trucks pose no threat to violation of any ambient air quality standard for any area or pollutant. However, Class I increment violations are possible at the 1.1 million ton per year (MTY) level of coal transportation. The annual increment (rather than the 3- or 24-hour case) would be the limiting condition. Class I increment violations are projected only above 1.1 MTY on Utah Route 12 near Bryce Canyon for unmitigated loads.

Assuming coal is transported unstabilized and subject to wind erosion in transit, Class II increment violations would occur beginning at the 4 MTY level on any highway. The Red Canyon area between Bryce Canyon and Panguitch appears to be the most susceptible location. Other potential violation areas have been identified near Escalante, Kanab, Hurricane, and Utah Route 20. Because unmitigated coal blow-off consists primarily of large particles which settle rapidly, no regional or significant visibility impacts attributable to truck haulage are anticipated.

In summary, the truck haul levels proposed for the low coal production scenario are not projected to violate local Prevention of Significant Deterioration (PSD) increments for any area. However, projected traffic volumes at Bryce Canyon (Class I) and Kanab (Class II) are within 10 percent of the limiting values for total suspended particulates (TSP). No truck-related standards violations are anticipated from any other pollutant. Limiting values of coal transportation for air quality are listed for each area, pollutant, and standard in Chapter 5 of the Air Quality Technical Report (ERT 1980).

Mitigation. Mitigation of TSP from coal blow-off is cost effective and would decrease emissions to less than 10 percent of their unmitigated values. Spraying the loaded coal with an emulsive binder is the most common practice.

Wildlife

Truck haulage of coal along the haul routes would increase wildlife highway mortality (road kills). The relative sensitivity of haul route is rated on Table 4-3. Almost all wildlife groups can potentially be affected by this impact, but significance is greatest when considering big game. Mule deer are most apt to be significant road-kill victims. Up to a 48 percent increase in traffic due to trucks hauling coal would occur under the low production scenario. Assuming a linear correlation between traffic volume and deer/vehicle collisions, truck haulage of coal would increase reported deer mortality by 82 deer per year. Reported values must be considered a minimum figure. This impact would be concentrated where haul route segments pass through mule deer critical winter range. Bald eagles may use road-killed animals as a food supply, thus increasing their vulnerability to being killed by a vehicle.

TABLE 4-3
POTENTIAL WILDLIFE HIGHWAY MORTALITY

Wildlife	HAUL							ROUTE						SEGEMENTS		
Categories	12	14	20	89a	89b	89c	89d	89e	89f	89g	89h	89i	98	136a	136b	389
Big Game	L	L	H	H	M	L	L	M	L	M	L	L	L	L	L	L
Unique, Threatend, or Endangered	L			L	L	L	L	L			L			L		
Furbearers				L	L	L										
Upland Game Mammals and Birds	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Small Mammals and Herpetofauna																
Other Avifauna																

IMPACTS (For comparison of impacts between haul route segments and not between wildlife categories)
L = Low
M = Moderate
H = High

Recreation

Increased heavy truck traffic would conflict with recreation traffic, increasing the probability of accidents and reducing the enjoyment of driving for pleasure and sight seeing. Significant recreation traffic conflicts would occur on all major truck routes. Impacts would be greatest on routes 12, 14, 89a-i, and 389 during the summer tourism high season. (See Transportation Section for greater detail.)

Land Use

Two principle land use impacts would result from truck haulage of coal out of the study area. Trucks large enough to haul 25-ton loads, operating 16 hours per day would generate noise levels which would be undesirable near sensitive land uses identified on Map 3-9. The impacts associated with this issue are addressed further in the Transportation section.

The second impact consideration would be traffic conflicts caused or aggravated by coal-related truck traffic. This issue is also discussed further in the Transportation section, but is discussed here because certain land uses inherently produce traffic conflict situations. Agricultural areas generate hazardous mixing of slow-moving farm equipment and high-speed through traffic, especially in narrow valleys where main roads provide access to fields. Some conflict would also occur with movement of livestock between grazing areas. Small communities with residential areas abutting main highways generate pedestrian-crossing hazards which are greatly intensified when schools or nursing homes are also present to focus crossings by children and the elderly. Recreation areas focus private auto traffic in limited sections of the highway network. This is a particularly severe problem in the study area which hosts several hundred thousand tourists annually.

One or more of these sensitive and traffic conflict-generating land uses is present on every identified truck haul route segment except segments 20 and 98 as illustrated on Map 3-9. Table 4-4 summarizes potential impact areas by route segment. Using raw numbers of potential impact points as a crude estimator, the truck haul routes from North Kaiparowits to Salina and from Alton to Salina generate the greatest truck haul impacts. Routes from Alton to Cedar City, South Kaiparowits to the Navajo Power Plant, South Kaiparowits to Flagstaff, and Alton to the Navajo Power Plant generate the least impacts.

Transportation

The transportation of coal by truck during the low production scenario would have an effect on both traffic operations on roadways comprising the haul routes and on adjacent land use development. The specific nature of the impacts generated is dependent upon several key variables, including the number of coal trucks, existing traffic demand on roadways, roadway geometrics, and traffic operating conditions. On a daily basis, an estimated 308 coal trucks each would be generated by the Alton and South Kaiparowits fields and 154 trucks by the North Kaiparowits field. The resulting average hourly truck generation

TABLE 4-4
POTENTIAL LAND USE/TRANSPORTATION CONFLICT POINTS

Truck Haul Route Segment	Agricultural Areas	Heavy Recreation Traffic (approx. mi.)	Potential Sensitive Land Uses[1] Residential Communities	Others
20	-	-	-	-
89a	2	-	4	6
89b	1	-	1	8
89c	1	20	1	-
89d (incl. Long Valley Juntion)	-	5	1	-
89e (incl. Kanab)	-	35	5	14
89f	-	5	-	-
89g	-	50	-	-
89h (incl. Glen Canyon City and Page)	-	15	2	4
89i	-	50	-	-
14 (incl. Cedar City)	-	45	1	33
389 (incl. Hurricane)	3	65	3	12
12 (excl. Escalante)	1	65	3	5
136a	2	-	1	-
136b	1	-	-	-
98	-	-	-	-

Source: ERT Project Team
[1]All sensitive uses in a residential community may not be subjected to truck impacts depending on location and internal routing

would be 40 trucks each (20 loaded, 20 empty) from Alton and South Kaiparowits and 20 trucks (10 loaded, 10 empty) from North Kaiparowits. A summary of the maximum hourly truck volumes on each of the haul route segments can be found in Item 25 in the assumptions. In determining the impacts generated by the coal trucks, a worst case approach based on the maximum possible utilization of each route was used.

The impact of the coal trucks on U-12 traffic flow would be most pronounced in areas of steep vertical upgrades and sharp horizontal curvature because of the reduction in operating speeds. Parts of U-12 have lengthy sections of vertical curvature in excess of 6 percent, such as east of Bryce Canyon and south of The Blues, Figure 4-1, and areas of pronounced horizontal curvature. The lateral clearance between the pavement edge and adjacent major drop-offs in elevation are minimal. With the accompanying narrowing of pavement width, the potential impact of trucks on operating speeds and vehicle maneuverability is of concern. For the large areas of vertical upgrade on U-12, a speed reduction in the order of 10 to 25 MPH from average auto operating conditions could occur. The reduction in operating speed would increase the probability of vehicle accident occurrence due to illegal passing on the two-lane facility.

In the areas of Bryce Canyon and Red Canyon, tourists frequently pull off along the side of U-12 in areas with scenic views. This creates a potential for accident occurrence because of the limited available pavement and shoulder area for trucks to pass parked autos. During periods of inclement winter weather conditions (ice, snow), truck maneuverability and operational safety could be restricted in the areas of severe horizontal and vertical curvature.

Trucks using U-12 would pass through the communities of Escalante, Henrieville, Cannonville, and Tropic. Several of these communities have residential development in close proximity to the roadway edge, exposing them to both truck noise and vibration effects. The repeated axle loadings of coal trucks would accelerate the deterioration of the pavement surface. The section of U-12 from the eastern boundary of Bryce National Park to Escalante appears to be particularly susceptible to this occurrence given the existing condition of the pavement surface. As the pavement surface deteriorates, both noise and vibration effects become more pronounced.

FIGURE 4-1. The Blues North of U-12 (Segment C13)

Pavement condition on U-20 is generally good; however, shoulders along the steeper sections are minimal. The loaded coal trucks proceeding west on U-20 to Milford would have to climb the upgrade from the Sevier River Valley to the peak vertical elevation just west of Bear Creek. Because of the length and extent of the vertical grade, the loaded coal trucks would reduce average auto operating speeds from 10 to 25 mph.

The summit of U-14 (9,764 feet) is the highest elevation that would be traversed by a truck haul route. Because of the elevations attained, the road is frequently closed during winter months because of snow and ice. During the spring thaw, rocks and shale mud slides frequently obstruct areas of the pavement. Because of wet roadway subbase conditions in the spring, a load limit of 20,000 pounds is often in effect.

U-14 also has several areas of lengthy vertical curves greater than 6 percent in grade. Loaded coal trucks would have to traverse the steep upgrade from U.S. 89 through Stout Canyon to Point Supreme. The downgrade from Point Supreme to Cedar City has sections exceeding 6 percent in grade. Equally important from the perspective of vehicle operational safety is the extreme horizontal curvature on the switchbacks descending into Cedar Canyon. The combined downgrade and horizontal curvature on the switchbacks could contribute to vehicle sideswipe accident occurrence, especially considering reduced lateral maneuverability of 25-ton coal trucks.

Land use on U-14 from U.S. 89 to just east of Cedar City is predominantly open space used for tourist activity. Because of the railhead location in the northwestern quadrant of Cedar City, coal trucks would have to cross several of the major streets in the more densely populated urban area.

The pavement on U.S. 89 between Kanab and Marysvale (truck haul segments 89 a, b, c, d, and e) is in generally fair condition. Areas of pavement deterioration have occurred due to frost heaving and roadway edge unravelling. The repeated axle loading from the 25-ton coal trucks could accelerate the deterioration of the pavement surface. Segments 89 a, b and c traverse areas of moderately rolling terrain, generally following the Sevier River Valley. Segment 89d through Long Valley has several areas of steep vertical grade with sharp horizontal curves. Because of the length of the vertical curves, loaded coal truck operating speeds on upgrades would be significantly reduced. The reduced operating speeds could increase accident potential because of illegal passing maneuvers. Segment 89e just north of Kanab also has areas of steep vertical grades that could result in decreased vehicle operating speeds from 10 to 25 mph. The significance of the reduced operating speeds due to the loaded coal trucks is much greater on U.S. 89 because of the relatively high average daily traffic flows.

FIGURE 4-2. Sink Valley south of Alton (Haul Route 136a and Segment C4)

An additional consideration is the compatibility of the coal truck traffic with the residential land use along U.S. 89 in areas of population concentrations such as Mt. Carmel, Orderville, Glendale, Hatch, Panguitch, Circleville, and Marysvale. The majority of these population centers also contain the retail service establishments for the area. Traffic activity into and out of the retail service establishments on U.S. 89 presents potential accident and traffic delay problems from coal truck through movement.

Truck haul route segment 136a from U.S. 89 to the town of Alton is a two-lane paved roadway. From Alton to the intersection with 136b, 136a is a graded roadway with either a compressed dirt or gravel surface (see Figure 4-2). The unpaved surface frequently becomes impassable during snow and heavy rains. The narrow roadway width in the paved and unpaved sections makes passing of two opposing vehicles extremely difficult. Segment 136b, Johnson Canyon Road, has a paved surface for approximately 10 miles in from the intersection with U.S. 89. The remaining section is unpaved with a dirt and gravel surface (see Figure 4-3). The narrow roadway width on the unpaved section of 136b makes the passing of two opposing vehicles difficult. Segments 136a and 136b both have generally flat to moderate grades. Operational issues associated with use of these routes include the stability of the roadway surface under repeated loadings of the 25-ton coal trucks and the load capacities of the existing iron grate crossings of streams.

Coal destined for the Warner Valley Power Plant south of Hurricane would follow Routes 389 and 59. Both Routes 389 and 59 are two-lane paved facilities generally passing through open space with scattered areas of agricultural and residential use. Recreation activities at Pipe Springs National Monument would be adversely affected by the increased traffic (up to one truck every 47 seconds) and noise levels. Route 389 from Fredonia to Route 59 has a gently rolling terrain. Route 59 at Hurricane Cliffs has a major downgrade proceeding westbound with several switchbacks in horizontal curvature. The access road to the Warner Valley Power Plant from Hurricane is paved for approximately 4 miles.

Haul route segment 89i running south to Flagstaff passes through the Navajo Indian Reservation. Increased truck traffic (up to 40 trucks per hour) would increase the number of livestock killed by collisions and would pose an accident hazard to children living along the highway. The steep downgrade at Echo Cliffs followed by a T intersection where the trucks would be required to come to a full stop could pose an accident hazard to heavily loaded coal trucks.

FIGURE 4-3. North End of Johnson Canyon (Haul Route 136b and Segment C8)

Socioeconomics

Socioeconomic impacts of truck haulage were not analyzed independent from impacts of coal development. See Overall Impacts of Coal Development: Low Scenario for combined discussion.

Noise

The greatest truck traffic flow is projected to occur on U.S. 89 between Johnson Canyon and Kanab (segment 89f). Noise levels at roadside exceeding 65 dBA would occur over 6 hours each day. This level is categorized as normally acceptable by Department of Housing and Urban Development (HUD) standards. Peak noise values are expected to be below 65 dBA (a typical daytime, urban value) at 1,000 feet from the road, and below 55 dBA (a daytime hospital zone value) at 1 mile away under early morning worst-case conditions. This would be above typical maximum permissible night-time noise levels of 45 dBA for hospital zones.

Coal Slurry Pipelines and Railroads

The following section includes two coal transportation options which are not part of the study scenarios but which could be viable for the transportation of coal out of the Kaiparowits region. These options are shipping coal by rail from the Alton lease area and transporting coal by slurry pipeline from the South Kaiparowits lease area. The maximum tonnages for the rail haul route to Milford presented in assumption 25 include the production of the Alton lease area. Thus the transportation analysis for the worst-case situations includes rail haulage from Alton. The water resources section also includes a discussion of the effect of shipping 20 MTY of coal from the South Kaiparowits lease area via a coal slurry pipeline utilizing water from Lake Powell.

Air Quality

Because normalized source terms were used in the local modeling of transport corridors, an assessment of both construction and operating phases was possible at each of the nineteen locations which were modeled. Both 24-hour and annual average time periods were evaluated for each area. The Air Quality Technical Report (ERT 1980) describes the assumptions and methodologies used in that analysis.

Slurry pipeline and railroad construction, although occurring during a 4 to 6-year period, is expected to produce moderate amounts of TSP. No air quality standards or TSP increments are anticipated to be violated as a result of this work. The anticipated emissions from the rail corridor construction are about

one-third of the limiting annual TSP Class II increment values. Construction-related emissions of gaseous pollutants would be trivial.

During the operating phase, emissions resulting from the slurry pipeline would be negligible. However, railroad emissions would be significant, and some mitigation would be required to meet both TSP ambient air quality standards and the TSP/PSD increments. The only ambient air quality standard impacted by rail transportation would be the annual TSP standard which would be violated once unmitigated rail coal haulage exceeded 37 MTY. The point where the South Kaiparowits to Milford line crosses the low pass north of Utah Route 20 appears to be the most sensitive location. The North Kaiparowits to Marysvale line west of Escalante would be a second sensitive location, but NAAQS for TSP would not be violated unless haulage exceeded 45 MTY there.

The TSP 24-hour Class II increment would accommodate at least 80 MTY per line of unmitigated rail coal transport throughout the study area. This level would be exceeded only by the worst-case high scenario on the route to Milford. The TSP 24-hour Class I increment would accommodate about 40 MTY unmitigated transport. This indicates that for both the worst-case medium and high scenarios, the South Kaiparowits to Milford line would need to be mitigated in corridor segments C10 and C5 to preclude violating the Class I increment at Bryce Canyon.

Unmitigated rail coal transportation is projected to cause significant impacts on both the Class I and II annual TSP increments and on the Class I SO_2 increment. In Class II areas, any rail line hauling in excess of 9 MTY would need to be mitigated to preclude Class II increment violations. Annual Class I TSP increment standards would be applicable to the South Kaiparowits to Milford rail line as it passes upwind of Bryce Canyon along the southern edge of the Paunsaugunt Plateau. Without mitigation measures, that section could accommodate only 4.2 MTY before Class I TSP increment standards would be violated. The only other significant pollutant associated with rail transportation is SO_2. The Class I annual SO2 increment near Bryce Canyon would not be violated until coal haul levels exceeded 45 MTY.

Appropriate mitigation measures and the effectiveness of the miti gation measures to reduce TSP emissions attributable to rail transport alone is discussed in detail under the medium and high coal production scenarios and in Appendix J.

Visibility

As with the truck haul transportation mode, the large-size coal blow-off particles from rail cars are not expected to cause visibility degradation, even in the unmitigated case. Construction dust plumes would be temporarily visible and would contribute to localized visibility degradation. Because they would be temporary at any one location, no significant impact on visual range is expected.

Topography and Geology

Cut and fill operations during railroad construction to maintain a 1.5 percent grade would alter topography slightly. A balance between cutting and filling is desirable for economic reasons; however, if this cannot be achieved, borrow pits may be required. A railroad would also require ballast for the road bed. The ballast must have certain characteristics which are generally met by some types of limestones, volcanic rocks, and quartzites. Gravel deposits having a high percentage of these rocks also may be acceptable. Such limestones and quartzites are available in the northern part of the northward-trending corridors. Vast quantities of volcanic rocks are present in the northward-trending corridors; however, they have not been investigated as a source for ballast. Ballast requirements would be on the order of 9,000 tons per mile of track.

Coal slurry pipelines can negotiate grades of 15 to 20 percent and thus could be built over more rugged terrain than a railroad. Construction of coal slurry pipelines is similar to that of oil and gas pipelines and would require much less cut and fill than a railroad. Impacts from construction would be relatively short-lived providing mitigation is successful.

Soils

Soils within the transportation planning corridors would be disturbed by construction operations. Impacts would result from mechanical handling and mixing of the topsoil, loss of topsoil to erosion, loss of topsoil through mixing with subsoil, and compaction of topsoil by construction equipment. These impacts need only be short-term in nature for both railroads and coal slurry lines if proper reclamation procedures are followed.

Certain soils may cause problems or otherwise be of concern within the transportation planning corridors. These are displayed on Map 3-2. Shallow soils may cause problems in burying a coal slurry line or may be difficult

to reclaim. Soils with high shrink-swell potential may demand more stringent engineering applications when constructing a bridge or overpass, or may require more ballast in constructing a railroad. Agricultural soils represent a valuable resource which would be disturbed during construction and, in the case of a railroad, lost from future production. Soils with high erosion potential can cause problems during and after the construction of a facility.

Water Resources

The construction of railroads and slurry pipelines would disturb the existing soil structure and vegetation, increasing sediment production and surface runoff to streams. Without a site-specific proposal it is difficult to quantify exact amount of increased runoff. However, the net effect on water should be temporary and occur only during the construction phase.

Potential slurry pipeline leaks and ruptures could occur. The chance of slurry line rupture in a stream is small but if it did occur, the spill would release relatively large quantities of pulverized coal which would affect the water quality of the stream. The potential impacts to water quality are further addressed in the wildlife section. A detailed discussion of the effects of slurry pipeline water requirements on water resources can be found under the analysis of the medium production level. If 20 MTY of coal were shipped from South Kaiparowits, approximately 16,000 acre-feet of Lake Powell water per year would be required. This water would most probably be available through water rights filings that are currently under application or through purchase of existing water rights.

Vegetation

Impacts to vegetation would consist of permanent area losses of various communities, forage losses for livestock, agricultural area losses, and losses or disturbance to potentially threatened or endangered plant species. Assessment of significant impacts is based on the relative carrying capacity (value) of different vegetation communities, the relative abundance of these communities within the study region, and the potential routing problems imposed by topography. Since the lengths of future rights-of-way within corridors cannot be determined, the relative percentage of different cover types were utilized (Table 3-6). Area losses resulting from constructing transportation facilities would be insignificant due to the relatively small area within the region which would be disturbed by constructing these components (less than 1 percent).

The significance of construction impacts would increase if topographic factors require a large number of switchbacks on railroads or conflicts with highly sensitive communities or endangered plants. Topographic limitations in Corridor Segments C10, C13, C15, and C17 may constrain routing options on these segments because of steep terrain and large changes in elevation. These segments are located adjacent to coal lease areas and represent links to other segments that follow more gentle topography along major valleys or cross more gently sloping plateaus.

Table 4-5 presents an assessment of the relative impacts of different transportation options on range and agricultural resources, and candidate threatened or endangered species. Corridor Segment C9 is the only segment where high impacts to grazing and agricultural resources could occur. This is based on the relatively large amount of agricultural land included in this segment (24 percent). Agricultural lands extend across the width of Corridor Segment C9 (Map 3-4), so routing options in the segment to avoid agricultural lands may be limited.

Adverse impacts to candidate and listed threatened and endangered species resulting from construction activities are expected to be the destruction or modification of habitat. The U.S. Fish and Wildlife Service (1980) cites future mineral exploration, industrial development, and related projects (railroad, pipeline, and transmission line corridors, highway and power plant construction, and urbanization) as the most probable potential threats to these species. Impacts would most likely occur in those corridor segments where topographic limitations and potential occurrence of candidate and listed species are both rated high. This combination exists for corridor segments C13, C14, and C15 (Table 4-5). It is most critical in segment C13 where populations of eight candidates are known to occur and a ninth is judged to have moderate potential for occurrence. One candidate is known to occur in segment C14 and another is judged to have moderate potential for occurring there. Only one candidate is known to occur in segment C15. In those segments where topographical constraints are significant and routing alternatives are limited, adverse impacts would be more likely to occur. Corridor segments with gentle terrain allow numerous routing alternatives and appear to provide the most potential for avoiding adverse impacts.

TABLE 4-5
TRANSPORTATION CORRIDOR IMPACTS ON VEGETATION

Corridor Segment	Topographic Limitations[1]	Grazing and/or Agricultural Resource Value[2]	Threatened or Endangered Species[3]
C1	L	L	H (12)[4]
C2	M	L	H (19)
C3	L	M	H (19)
C4	L	M	H (5, 7); M (8)
C5	M	M	L
C6	M	M	H (4, 9, 15)
C7	M	M	H (19)
C8	L	M	L
C9	M	H	L
C10	H	M	M (11)
C11	L	M	H (10, 19)
C12	L	M	L
C13	H	M	H (1,2,3,5,6,13, 14,18); M (16)
C14	H	M	H (13); M (11)
C15	H	M	H (13)
C16	M	L	H (1,13)
C17	H	L	L
C18	L	L	L

[1] L = Low; terrain gently sloping, numerous routing alternatives available
M = Moderate; terrain a mixture of gently sloping and steep terrain, routing options may be very limited in some locations.
H = High; terrain very steep, characterized by numerous canyons and rock outcrops, routing options very limited throughout most of the corridor segment.

[2] L = Low; livestock carrying capacity >40 acres per AUM.
M = Moderate; livestock carrying capacity is 20 to 80 acres per AUM
H = High; livestock carrying capacity is less than 20 acres per AUM

[3] L = Low; little or no potential for occurrence, based on habitat and known occurrences.
M = Moderate; moderate potential for occurrence, based on habitat and known occurrences.
H = High; high potential for occurrence or species is known to occur in corridor, based on habitat and known occurrences.

[4] Numbers refer to the following species:
1. *Cympoterus higginsii Higgins* biscuitroot
2. *Cymopterus minimus* Cedar Breaks biscuitroot
3. *Lomatium minimum* Cedar Breaks biscuitroot
4. *Erigeron religiosus* Clear Creek fleabane
5. *Lesquerella rubicundula* Bryce bladderpod
6. *Silene petersonii* var. *minor* Red Canyon catchfly
7. *Ranunculus acriformis* var *aestivalis* Autumn buttercup
8. *Astragalus lentiginosus* var *ursinus* Bear Valley milkvetch
9. *Astragalus striatiflorus* Escarpment milkvetch
10. *Psoralea epipsila* Kane breadroot
11. *Psoralea pariensis* Paria breadroot
12. *Phacelia anelsonii* MacBride scorpion plant
13. *Phacelia mammallarensis* Nipple Bench phacelia
14. *Eriogonum aretioides* Widtsoe buckwheat
15. *Eriogonum zionis* var. *zionis* Zion buckwheat
16. *Castilleja aquariensis* Aquarius paintbrush
17. *Castilleja revealii* Reveal paintbrush
18. *Penstemon atwoodii* Atwood beardtongue
19. *Pediocactus sileri* Siler cactus

TABLE 4-6
POTENTIAL WILDLIFE IMPACTS BY CORRIDOR SEGMENT

	SLURRY PIPELINE OR RAILROAD TRANSPORTATION (CONSTRUCTION AND OPERATION)																	
	CorridorSegments																	
Wildlife Categories	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18
Big Game	M	M	M	L	M	L	L	H	L	L	M	H	M	L	H	M	L	
Unique, Threatened, or Endangered				M	L		L				L		L					
Furbearers				L														
Upland Game Mammals and Bird	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Small Mammals and Herpetofauna																		
Other Avifauna				L														
Unique, Threatened, or Endangered Fishes	L.																	
Game Fish				L														
Other Fish				L	L				L			L	L					

Source: ERT Project Team IMPACTS (For comparison between corridor segments and not between wildlife categories)
L = Low
M = Moderate
H = High

Wildlife impacts of rail and slurry transportation modes would occur primarily as a result of destruction or alteration of vegetative communities during construction activities. Loss of habitat would cause a small reduction in the carrying capacity of the region as a whole. Larger more mobile animals would be displaced to adjacent similar habitats, possibly causing a temporary increase in competition in those areas until populations stabilize. Construction of railroad or slurry transportation systems would impact aquatic habitat by increased sedimentation. The largest amount of earthwork would be required in areas of steepest terrain which often coincides with the best aquatic habitat in the region, so impacts of construction may be significant in localized areas. Appropriate engineering measures could reduce the significant impacts. With proper care, impacts to endangered Virgin River fishes would not be expected due to construction of slurry lines and railroads. Table 4-6 compares the relative impacts of transportation corridor segment utilization for various wildlife groups. Comparative tables such as this are intended as planning tools to aid responsible agencies in making corridor evaluations for specific development proposals. Ratings are subjective and relative only within the wildlife group.

Once constructed, operational impacts of railroads or slurry lines are expected to be small. Trains would collide with and kill some birds and animals, and slurry lines may leak or rupture, resulting in short-term impacts to a localized area. Slurry line breaks would occur at a rate similar to that of other liquid pipelines or about 0.0012 breaks/mile/year (ICC 1979). The chance of a slurry line rupturing in or near a stream containing fish is much smaller because stream crossings would comprise a very small portion of any right-of-way.

Spills resulting from slurry pipeline breaks would release relatively large quantities of pulverized coal and would result in much greater sediment impacts to aquatic ecosystems than the coarse-sized coal hauled by rail or truck. However, pulverized coal itself is not toxic to aquatic organisms, and the low specific gravity of coal compared to mineral sediment would allow more rapid downstream dispersion of such a slurry spill than would occur with an equal sized introduction of mineral sediment. As a result, sediment impacts to aquatic ecosystems as a result of slurry spills would only be severe in the immediate vicinity of the spill.

Since coal contains soluble compounds, some of which are toxic, water contamination of a receiving stream from the water carrier of the slurry is of potential concern. No leaching studies of the coals in the area are known, so the magnitude of water contamination that might result from a slurry spill is unknown. Additionally, corrosion inhibitors might be toxic (depending on the inhibitor chosen), but choice of an inhibitor must await project-specific studies. Where spills occur in flowing waters, such water contamination is highly transient. In most instances, the alkaline receiving stream character coupled with the transient pollution and downstream dilution should result in low level impacts. Only for ex-

TABLE 4-7
ARCHAEOLOGICAL RESOURCE IMPACTS FOR SLURRY PIPELINE AND RAILROAD

CorridorSegment	Length (mi)	Expected Number of Sites Within R-O-W	
		Pipeline 75 ft R-O-W	Railroad 200 ft R-O-W
C1	60	6	17
C2	10	1	N/A
C3	13	1	2
C4	60	7	18
C5	8	2	5
C6	33	7	N/A
C7	44	3	7
C8	16	4	N/A
C9	30	4	10
C10	15	4	10
C11	18	3	7
C12	22	0	N/A
C13	61	4	11
C14	16	3	7
C15	12	2	5
C16	14	2	5
C17	26	3	8
C18	52	6	12

Source: ERT Project Team

tremely localized populations would significant impacts be anticipated.

Groundwater withdrawal for slurry pipelines would reduce flows in the East Fork of the Virgin River. This would impact aquatic ecosystems by reducing their size and by reducing the ability of streams to assimilate inflowing lower quality water and incoming sediments. Further discussion is provided in the Wildlife Section of the medium scenario. In most situations, significant effects occur when flows are reduced by approximately 25 percent and major changes in the character of aquatic ecosystems are virtually assured with 60 to 75 percent reductions in flow.

Paleontological Resources

Construction of slurry pipelines and railroads would entail physical disturbances to sediments which may result in direct impacts to some paleontological resources in the study area. However, since the paleontological resources generally tend to occur in limited, isolated pockets, and because the actual physical disturbances to sediments by construction in the transportation corridors would be limited, it is estimated that minor direct impacts to paleontological resources would be localized.

Minor indirect impacts to paleontological resources in transportation corridors would result primarily from the increased accessibility and use of this land. The most extensive impacts would occur within approximately 5 miles of roads by amateur fossil collectors, 'rock hounds', and other non-scientific personnel who would collect and vandalize the resources.

Archaeological Resources

As indicated in Chapter 3, the study area contains numerous archaeological sites some of which would be adversely affected by construction of coal slurry pipelines or railroads. Following the methodology (described in the Coal Production section) developed for this study, the projected distribution of archaeological sites within the overall corridor segments has been determined (see Table 4-7). As indicated, the number of sites associated with construction of a slurry pipeline for each segment ranges from 0 to 7. As expected, the number of archaeological sites associated with construction of a railroad would be greater and range from 2 to 18 sites per corridor segment.

The numbers should be interpreted as representing first approximations of levels of potential impact to archaeological sites and are intended to be used as comparative indicators between various corridors. Accurate quantification of actual site numbers in specific areas must result from sample or intensive surveys of the particular areas themselves. The significance of archaeological resources impacts would be associated with the value of the specific sites impacted.

FIGURE 4-4. East Side of the Cockscomb (Segment C14)

Native American Concerns

Because Native American sacred resources exist in all transportation corridors, it is probable that any development alternative requiring excavation would adversely impact these resources. While exact specification of the location of sacred resources is not cited here, it appears that the width of the valley through which a proposed transportation alternative would pass would affect the probability of impacting specific resources, that is, the narrower the valley the more concentrated the sacred resources. Johnson Canyon (segment C8) is an example of a narrow valley containing sacred resources which could be affected by pipeline construction.

Visual Resources

The principle visual effect of a slurry pipeline would be clearing of the right-of-way during construction which would result in landscape disruption. Effects of clearing would be greatest in forested areas and in areas of rough terrain where blasting and alteration of the natural land form would occur. Changes would be most noticeable in foreground and middleground views, but would also be visible in background views if contrasts were extreme.

It is assumed that pipelines could be reasonably accommodated with standard reclamation efforts in BLM VRM Class III and Class IV areas and USFS M and MM areas (see Map 3-7). However, much greater difficulty would be encountered in meeting the standards of higher visual class areas. Corridor segments with areas of high impact potential would be as follows:

C1. A Class II area with highly rated scenic quality where the pipeline would be in the foreground viewshed of a principle access route to Zion National Park.

C6. A Class II area with highly rated scenic quality in the foreground near Colorado City, and a Class II area with more common scenery but located in the foreground for the main route from Zion National Park to Kanab.

C13. A mixed rating area including some R ratings on the Dixie National Forest Aquarius Plateau unit near the entrance to Bryce Canyon National Park. The area is a ponderosa pine forest and is foreground for primary roads from Bryce Canyon National Park to Johns Valley (north) and Escalante and Capitol Reef

FIGURE 4-5. Cottonwood Canyon (Segment C15)

National Park (east). Terrain in portions of the area is quite rugged.

C14. A large Class II area. The northerly part of the segment has highly rated scenic quality in the background for most viewers. The southerly part of the segment has moderate scenic quality but is in the foreground view of very high traffic volumes along highway US 89 (Figure 4-4).

C15. A Class II area of high scenic quality along the very rugged Cockscomb formation (Figure 4-5).

C18. A Class II area with highly rated scenic quality in the foreground for all visitors to Lake Powell at the area near Glen Canyon Dam (see Figure 4-6).

Visual impacts of the pipeline would be noticed until reclamation efforts were successful. The time required for successful reclamation would vary with soil and moisture conditions but could be in the range of five to ten years.

Visual effects associated with railroads would be similar in many ways to pipeline effects; however, they would be more severe and longer lasting in certain situations. Route clearing of a wider right-of-way would create more noticeable geometric shapes in contrasting colors. In addition, more stringent grade and curve limitations would require substantial cut-fill areas in rough or steep terrain. Severe cuts and fills would be more difficult to revegetate than a right-of-way following natural contours more closely, thus color contrast would continue for a longer period of time, perhaps indefinitely in some locations. A typical railroad would meet contrast standards in VRM Class IV areas where activities may be a "dominant feature of the landscape." Class III standards, which require an activity to "remain subordinate to the existing characteristic landscape," would be much harder to meet, especially where the area would be in a "foreground-middleground" distance zone, close to viewers. Sensitive, mitigating design treatment would be required in such cases.

Recreation Resources

Recreation traffic conflicts with slurry pipelines would be relatively minor, occurring only during the construction period. Such conflicts would move gradually through the affected corridor segments and would thus be short-term in any given location. Moderate recreation traffic conflicts would occur where rail lines cross major recreation routes. Recreation traffic would be delayed periodically, but typically for not more than 2.5 minutes at a given crossing.

FIGURE 4-6. Glen Canyon Dam and Lake Powell (Segment C18)

Wilderness Resources

Development of coal and coal transportation facilities in accordance with the study scenarios would conflict with potential wilderness areas and wilderness study areas at several locations in the Kaiparowits study area. An area of the Dixie National Forest in corridor segment C1 has been recommended by the USFS to Congress for designation as a wilderness area (see Map 3-8). In addition to the USFS wilderness proposal, the BLM has proposed designation of lands as wilderness study areas on significant portions of corridor segments C6, C7, C10, C13, C14, and C15 and on approximately 10 percent of the South Kaiparowits lease area (Map 3-8). BLM wilderness study areas will be finalized by November 15, 1980. Lands so designated will be managed "... so as not to impair their suitability for preservation as wilderness..." (U.S.D.I., BLM 1979) until Congress has acted on presidential recommendations regarding the wilderness study areas. If wilderness study areas are designated, it will require further planning and environmental impact statements prior to a decision by the Congress of the United States. Since the Secretary of the Interior has until October 1991 to make wilderness recommendations to the President and the President is not required to report his subsequent recommendations to Congress until October 1993, wilderness study areas would be managed under restrictions imposed by Section 603 of the Federal Land Policy and Management Act until the mid-1990s. Throughout the BLM planning process, conflicts are identified. Recommen-

FIGURE 4-7. Four Mile Bench on the South Kaiparowits Coal Lease Area (Segment C17)

dations are then made to Congress as to boundary adjustments or suitability of areas based on resource conflicts (such as energy development and transportation). BLM hopes to complete wilderness planning and EIS preparation before the 1991 deadline.

BLM Interim Management Policy (U.S.D.I., BLM 1979) for lands under wilderness review limits granting of new rights-of-way across such lands and greatly restricts mineral development uses. The most significant conflicts between proposed wilderness study areas and transportation planning corridors occur in corridor segments C10, C13, C14, and C15 where terrain acts in combination with the proposed wilderness study areas to greatly restrict possible development of rail and slurry lines. Corridor segments C1, C6, and C7, although greatly narrowed by the proposed wilderness study areas, would be less significantly affected because the most accessible terrain for construction of rail or slurry lines is not recommended for further wilderness review.

Land Use

Land use impacts from coal slurry pipelines fall into three general categories: construction noise and traffic effects on sensitive uses; disruption of surface use of the right-of-way during construction, and disruption of productive cropland due to potential pipe rupture and spillage. Construction noise, although obtrusive, would be a very short-term (one construction season) effect because the construction activity would move fairly rapidly. In addition, it would be possible, in all corridor segments, to avoid communities and sensitive land uses by at least 1 mile.

Disruption of surface use during construction would be most significant where cropland would be crossed by a pipeline. However, there is ample space for a pipeline right-of-way to avoid croplands in all corridor segments except C1, C9, C12, and C13. The minimum cropland removed from production would be 117 acres in segment C1, 45 acres in C9, 9 acres in C12, and 18 acres in C13. Although there apparently is ample space to avoid croplands in the remaining corridor segments, if other considerations compelled use of cropland for pipeline right-of-way, the worst case would occur in segment C4 where 243 acres would be lost from production. Where cropland is crossed, production would be lost for one year. The estimated value of lost production would be $150 per acre based on 1978 average yield and price figures for hayland, hay being the most prevalent crop in the study area (Utah Department of Agriculture 1979). Some forest production capacity would be lost, particularly in segments C4 and C13, but existing timber could be harvested

TABLE 4-8
POTENTIAL LAND USE/RAIL AND PIPELINE CONFLICT POINTS

Rail/Pipeline Corridor Segments	Agricultural Areas			Heavy Recreation Traffic Crossings		Potential Sensitive Land Uses		
		Cropland						
	Prime Soils[2]	Alternative Available	No Alternative	Alternative Available	No Alternative	Hospitals	Schools	Residental Areas
C1	25 mi	13 mi	13 mi	-	21	1	10	7
C2	-	-	-	-	-	-	-	-
C3	2 mi	-	-	-	-	-	-	-
C4	29 mi	27 mi	-	-	1	1	2	5
C5	-	-	-	-	-	-	-	-
C6	10 mi	-	-	-	-	-	-	-
C7	-	-	-	2	-	-	-	-
C8	8 mi	3 mi	-	-	-	-	-	-
C9	21 mi	7 mi	5 mi	-	-	-	2	4
C10	-	-	-	-	-	-	-	-
C11	-	-	-	1	-	-	-	-
C12	16 mi	5 mi	1 mi	-	-	-	-	2
C13	19 mi	17 mi	2 mi	1	-	-	1	3
C14	-	-	-	1	-	-	-	-
C15	-	-	-	-	-	-	-	
C16	-	-	-	1	-	-	-	1
C17	-	-	-	-	-	-	-	-
C18	-	-	-	1	1	1	3	1

Source: ERT Project Team

[1]Excludes I-15 crossing which is assumed to be grade separated
[2]Total tract of incidence; actual prime parcels may be less

prior to construction and the value of long term production loss is not readily quantifiable. No significant impacts on mineral resources would be expected.

The impacts from a pipe rupture and spill would be significant for approximately one year on the relatively small area of cropland that would be affected. However, the likelihood of a spill at any given location is estimated at 0.0012 spills/mile/year, and since cropland makes up less than 1/3 of any corridor, the likelihood of a spill on cropland would be low. Spillage on other than cropland, although undesirable, would not have significant effects on the use of the land because the productivity lost per acre would be lower.

Potential land use impacts due to railroad development include construction noise and traffic effects on sensitive uses, operating noise and vibration effects on sensitive uses, crossing hazards near schools and other high traffic volume uses, potential access blockage for emergency services, and usurpation or preclusion of other uses from railroad rights-of-way. It would be possible to avoid residential areas and other sensitive land uses in all corridor segments during the construction of a rail line. Intersection with major recreation traffic routes would be impossible to avoid in corridor segments C1, C4, and C18 and could occur in segments C7, C11, C13, C14 and C16 (see Table 4-8). If residential areas were avoided, high-volume crossing hazards associated with land uses would be minimal.

Usurpation of current productive uses would be most significant where cropland would be converted to a railroad right-of-way. Assuming the land is currently used for hay production, the annual loss per acre would be approximately $150/acre. Minimum acreage losses for corridor segments where cropland could not be avoided would be 312 acres in segment C1, 120 acres in C9, 24 acres in C12, and 48 acres in C13. The worst-case loss from a single corridor segment would be 648 acres in segment C4 if all possible croplands were crossed by a rail right-of-way. Losses of grazing lands are estimated in the low production scenario discussion, but the production value per acre of grazing land would be much lower than for cropland. Losses of forest production capacity would be similar to those described for slurry pipelines above. The loss could be slightly greater due to the wider right-of-way for a railroad, but actual effects would depend on the specific construction activity within the right-of-way. Little or no effect would be expected for mineral resources.

Transportation

At the medium and high coal production

FIGURE 4-8. East Fork of the Sevier River in Black Canyon (Segment C13)

levels, railroads and slurry pipelines would be the primary transportation modes. The 9 MTY of coal produced from the Alton field would be transported by slurry pipeline. Slurry pipeline could also be used to transport coal from the North Kaiparowits field at the 15 MTY medium production level. For the medium (30 MTY) and high (45 MTY) production levels for South Kaiparowits, and the high (30 MTY) production level for North Kaiparowits, coal would be transported in unit trains to one of the potential destinations under consideration. At a 30 MTY production level, an average of 28 trains per day would be needed (14 loaded outbound, 14 empty inbound). The average number of trains per day increases to 42 (21 loaded outbound, 21 empty inbound) at the 45 MTY production level. The number of unit trains required to transport the maximum coal tonnages are shown in Item 25 in the assumptions.

The extent of right-of-way preparation within each transportation corridor is dependent upon several key factors including facility requirements, topography, subsurface conditions, and number of required grade separated crossings of water bodies, roadways, and areas of major grade differential. For example, a railroad right-of-way would require 24 acres per mile while a slurry pipeline would require only 9 acres/mile. Because of the severity of the topography in several of the corridors, the alignment alternatives within each corridor for the rail and pipeline may be quite limited.

Rail and pipeline construction in corridor segments C13 and C17 providing access to the Kaiparowits Plateau would require extensive engineering and right-of-way preparation because of the major grade differentials in the topography of the area (Figure 4-7). The terrain is extremely rugged with varying subbase conditions and geological formations. The extremes in grade present relatively greater difficulty to the railroad construction and operation because of the basic design limitations in unit train rail line horizontal and vertical curvature.

The northern part of C13 passing through Johns Valley paralleling the East Fork of the Sevier River has a more moderate terrain configuration with the exception of the area around Orisis (see Figure 4-8). Corridor segment C9, which parallels the East Fork of the Sevier River before turning north along U.S. 89 is characterized by rough terrain on its east-west section along U-62. The topography is more moderate in the northerly section of C9 and in pipeline corridor segment C12 to Koosharem. The pipeline alignment through C12 would have to circumvent Otter Creek Reservoir on the east side of U-62. Coal transportation system construction in the northern part of corridor segment C9 would have to avoid the area of Piute Lake.

Transportation corridor segments C14, C15, and C16 and C18 connect the Kaiparowits Plateau coal lease areas with points to the west and south. Right-of-way suitable for railroad construction in C15 is limited

FIGURE 4-9. The Paria Box, looking east (Segment C14)

because of the extreme variations in vertical elevation along the Cockscomb formation (Figure 4-4) and Cottonwood Creek (Figure 4-5). The extreme topography of the Cockscomb formation extends into C14. The one suitable rail crossing of the Cockscomb occurs at the point where the Paria River cuts across the formation. This area is known as the Paria Box (see Figure 4-9). The topography in C16 is less severe than that observed in C14 and C15, generally consisting of modestly rolling terrain. The major natural feature in C18 is the required crossing of Glen Canyon and the Colorado River (see Figure 4-6). The topography in Arizona is generally moderate, consisting of flat and rolling terrain.

Transportation corridor segments providing access to the Alton lease area are less restrictive in their topography to pipeline and railroad construction than the corridors serving the Kaiparowits Plateau. Pipeline corridor segment C8, paralleling Johnson Canyon Road (Figure 4-3), has generally moderate topography. At the base of the White Cliffs, the area of moderate terrain narrows, but not to an extent to prohibit pipeline construction. Corridor segment C5 to the west does have grade differentials in the area of Black Mountain. Similarly, C10 to the east of the Alton fields is characterized by areas of rugged terrain which would have to be circumvented by rail lines.

Corridor segments C3, C7, and C11 to the south of the Alton fields are characterized by generally moderate terrain. The major topographic consideration in C7 is the Kanab Plateau area contiguous to Kanab Creek in Arizona. Both the corridor segment C2 approach to Hurricane and the C1 connection to Cedar City require traversing Hurricane Cliffs (Figure 4-10), a major area of grade differential running north- south in southwestern Utah.

Corridor segment C4 connects Alton with Milford. The portion of C4 paralleling U.S. 89 and the Sevier River is characterized by rolling terrain (Figure 4-11). The east-west segment of C4 paralleling U-20 is much more rugged in its topography. The topography in this part of C4 has lower elevation valley areas interspersed with mountainous terrain that presents problems for rail construction and operation.

Railroad and pipeline construction in the transportation corridors would require the estimated number of construction workers and daily vehicle trips shown in Table 4-9. Because of the length of the transportation corridors, construction worker home origins would be distributed among the population centers located between the coal production areas and the transportation destinations. Thus, the impacts of the commuter traffic would be most concentrated at the construc-

FIGURE 4-10. Hurricane Cliffs along I-15 (Segment C1)

tion site area along the corridor. In addition to the construction worker traffic impact, truck transport of railroad and pipeline construction materials would result in increased traffic demand on regional highway facilities. Because of the potential scheduling overlap in railroad and pipeline corridor construction, some cumulative traffic impacts could occur.

Within each transportation corridor, the construction of the pipeline or railroad would necessitate the temporary detouring of traffic when highway crossings are encountered. The disruption of traffic flow would be most pronounced on the high volume roadways such as I-15 and U.S. 89. The rail line routes to Cedar City and Milford would require grade separations from I-15. U.S. 89 may require grade separation from a railroad. Whether crossings are at grade or grade separated, some degree of traffic disruption would occur during the construction period. Table 4-10 lists the roadway facilities that would require crossing in each transportation corridor.

The potential for vehicle delay at rail crossings is one of the implications of coal transportation that is specifically associated with the use of unit trains. Unit trains operate intermittently and are not easily grade-separated from the road network. As a result, several at-grade crossings could occur that would periodically stop traffic on the roads crossed. The estimates of vehicle delay for each at-grade rail crossing are shown in Table 4-11 for the medium production alter native and Table 4-12 for the high production alternative. The methodology for these estimates is presented in Appendix G. In both tables, the maximum potential tonnage of coal is assumed to be carried on each route in order to estimate the delay under worst case conditions. These estimates permit a comparison of the routes and an identification of the critical intersections along each route.

In addition to delay, the safety aspects of coal transportation are also an important operational consideration. For rail transportation the most critical safety issue is the potential for accidents at the railroad/highway grade crossings. To evaluate the significance of this potential problem and to identify the critical crossings, an estimate of the number of accidents per year at each crossing was made (see Appendix G). The results provide an estimate of the number of accidents per year for each crossing with each of three classes of warning devices. The two key factors in determining the hazard levels are the traffic levels on the road and the type of warning device used. For example, the dirt roads along the route to Cedar City have very little traffic (ADT is less than 100 each), and they would have a relatively low number of accidents per year expected at medium production (0.070 accidents/year on each of the dirt roads). In

FIGURE 4-11. Sevier River Valley (Segment C4)

contrast, segment 89g has approximately forty times more traffic on the route to Page (ADT is 3,900 at medium production) and would have over ten times as many accidents per year expected at the same production level (1.020 accidents/year). Although the hazard level does not increase in direct proportion to the traffic, the traffic does make a significant difference in the number of accidents expected.

Of even greater significance is the type of warning device used. A 70 percent reduction in hazard level is gained by changing from warning classes 1-4 to classes 5-7, and a 90 percent reduction in hazard is gained by changing from classes 1-4 to class 8 (see Appendix G for descriptions of warning classes). On haul route segment 89g on the route to Page, this would result in a change from 1.020 accidents/year with signs (Class 2) or crossbucks (Class 4) to 0.310 accidents/year with flashing lights (Class 7) to 0.100 accidents/year with automatic gates (Class 8). The results given in Tables G-5 and G-6 in the appendix can be used to determine the appropriate class of warning device to be used at each intersection to reduce the accident hazard to an acceptable level.

Socioeconomics

Construction of a coal slurry pipeline from the Alton lease area to Washington County would increase the populations of the Kanab and Hurricane areas by approximately 40 percent each for a three-year period. Construc-

TABLE 4-9
RAILROAD AND PIPELINE CONSTRUCTION EMPLOYMENT TRAFFIC BY TRANSPORATION CORRIDOR

Coal Transportation Mode	Corridor Route Origin	Corridor Route Destination	Total Construction Employment	Home Origin of Construction Workers: No. of Employees	Location	Duration (Yrs)	Daily Trips
Slurry Pipeline	Alton	Warner Valley					
			700	245	St. George	3	377
				455	Kanab	3	700
	North Kaiparowits	Koosharem	780	390	Greenwich/ Koosharem	3	600
				390	Escalante	3	600
Railroad	South Kaiparowits	Cedar City	1,100	275	Hurricane	4	423
				275	Fredonia	4	423
				75	Glen Canyon	4	423
				275	Transient Along Route	4	423
	South Kaiparowits	Milford	1,045	262	Beaver	4	403
				261	Alton	4	403
				261	Glen Canyon	4	403
				261	Transient Along Route	4	403
	South Kaiparowits	Flagstaff	825	618	Glen Canyon	2	950
				207	Transient Along Route	2	318
	North Kaiparowits	Salina	990	366	Antimony	2	563
				366	Escalante	2	563
				258	Transient Along Route	2	397

Source: ERT Project Team

tion of a coal slurry pipeline from the North Kaiparowits lease area north through Piute County would more than double the respective populations of the Escalante and Greenwich/Koosharem areas. For Kanab and Escalante population effects of this magnitude would represent the early stages of coal development related impacts. For Hurricane and Greenwich/Koosharem, where little or no impact from other aspects of coal development is anticipated, these effects would cause some significant, though relatively short-lived, problems.

The Alton slurry line would add an estimated 700 jobs to the local economy for a three-year period. The North Kaiparowits line would add an estimated 780 jobs in both cases, slightly under 85 percent would be heavy construction type jobs and would require importation of workers. Sequential construction, as anticipated in the scenarios would reduce the overall importation of workers and population because many would presumably move from the first job to the second.

Other aspects of socioeconomic impacts of slurry pipeline construc tion were not analyzed independent from impacts of coal development. See Overall Impacts of Coal Development: Medium and High Scenarios for combined discussion.

Population Impacts of Alton Coal Slurry Pipeline

	Total Impact	Hurricane	Kanab
1981	2,250	790	1,460
1982	2,300	805	1,495
1983	2,240	785	1,455

TABLE 4-10
POTENTIAL HIGHWAY CROSSINGS BY TRANSPORTATION CORRIDOR

Transportation Corridor	Potential Highway Facility Crossing
C1	59, 9, 15
C2	—
C3	389, 59
C4	136a, 89b, 89c, 12, 20
C5	136a
C6	89e
C7	89(ALT.), 389
C8	136b
C9	62, 89o
C10	—
C11	89g
C12	62
C13	22, 12
C14	89g
C15	—
C16	89g
C17	—
C18	89h, 89i, 98

Source: ERT Project Team

Population Impacts of North Kaiparowits to Koosharem Area Coal Slurry Pipeline Construction

	Total Impact	Escalante	Greenwich/ Koosharem
1984	1,803	902	902
1985	2,153	1,076	1,076
1986	1,891	945	945

Construction of a railroad or railroads for coal transportation from the study area would have significant population impacts on several communities in the area as shown on Table 4-14. These impacts would last only 2 to 4 years but resulting effects on services would be significant for the short-term because of the difficulty of providing some services on a short-term basis. Compare for examples, figures from Table 4-14 with stabilized year 2000 figures for the same towns in Table 4-25 and with Appendix K.

Other aspects of socioeconomic impacts of railroad construction were not analyzed independent from coal development impacts See Overall Impacts of Coal Development: Medium and High Scenarios for combined discussions.

Socio-cultural

The north corridor routes, including a railroad from North Kaiparowits through Corridor Segment C9 or a slurry line from North Kaiparowits through Corridor Segment C12, would result in significant socio-cultural impacts on parts of Garfield and Piute Counties. The populations of communities like Antimony, Escalante, and Greenwich-Koosharem would increase several fold. Present community facilities would be unable to meet the needs of the much larger population. Local lifestyles would be changed as large numbers of outsiders with different backgrounds and different recreational and leisure patterns move into the communities. Typical problems could include increased local crime, more family-related problems, increased alcohol and drug abuse, and increased conflict between old-time residents and newcomers. Primary positive benefits would be associated with new employment opportunities for current resi dents and the opportunity for former residents to return home.

The northwest corridor, which would involve the construction of a railroad from South Kaiparowits to Milford, would impact primarily on Kane and Beaver Counties. Major impacts would occur in Alton, which has a current population of about 60 people and which would mushroom to nearly 1,000 people in 1981. Such growth would significantly change the peaceful, slow-moving way of life of this small community. On the other hand, Glen Canyon City, which is a former boomtown, would probably experience many positive benefits. Most residents of this small community favorably anticipate future coal-related growth and hope to once more become a thriving community as during the construction of the Glen Canyon Dam. Impacts on the communities of Milford and Beaver in Beaver County would be less significant because their populations are large enough to absorb much of the new growth.

The western corridors, including the railroad from South Kaiparowits to Cedar City and the Alton slurry pipeline, would impact primarily on communities in Kane and Washington Counties in Utah and on Fredonia, Arizona. Fewer impacts would occur in the larger communities of St. George and Kanab. However, the small communities would experience serious difficulties in providing necessary services to the incoming population and would experience the greatest change in local lifestyles. Many of these communities face a serious dilemma. They would

TABLE 4-11
VEHICLE DELAY ESTIMATES FOR MEDIUM PRODUCTION LEVEL

Highway Route Segment	No. Vehicles Delayed for each peak hour crossing		No. of Vehicles Delayed per weekday	
	Signalized	Non-Signalized	Signalized	Non-Signalized
South Kaiparowits to Page				
89g	21	19	247	218
South Kaiparowits to Cedar City				
89g	20	17	228	202
Alt. 89	6	5	63	56
59	6	5	63	56
9	10	9	118	104
17	6	5	70	62
South Kaiparowits to Milford				
89c	24	21	332	293
20	2	2	25	22
21	4	4	57	50
South Kaiparowits to Salina				
12	36	32	418	370
22	2	2	22	20
62	2	1	18	16
89a	11	10	133	118

Note: Average time delay per train would be 2.2 minutes for a signaled crossing and 1.9 minutes for a nonsignaled crossing.

TABLE 4-12
VEHICLE DELAY ESTIMATES FOR HIGH PRODUCTION LEVEL

Highway Route Segment	No. Vehicles Delayed for each peak hour crossing		No. of Vehicles Delayed per weekday	
	Signalized	Non-Signalized	Signalized	Non-Signalized
South Kaiparowits to Page				
89g	22	20	433	383
South and North Kaiparowits to Cedar City				
89g	23	21	454	401
Alt. 89	6	5	105	93
59	6	5	105	93
9	10	9	196	174
17	6	5	117	104
South and North Kaiparowits and Alton to Milford				
89c	24	22	529	468
20	2	2	39	35
21	4	4	89	79
South Kaiparowits to Salina				
12	70	62	1,361	1,204
22	2	2	37	33
62	2	1	31	27
89a	11	10	222	196

Note: Average time delay per train would be 2.2 minutes for a signaled crossing and 1.9 minutes for a nonsignaled crossing.

TABLE 4-13
POPULATION IMPACTS OF RAILROAD CONSTRUCTION

NORTH KAIPAROWITS TO MARYSVILLE ROUTE

	Total Impact	Antimony	Escalante	Garfield County Area	Piute County Areas
1985	3,611	1,336	1,336	578	361
1986	3,994	1,478	1,478	639	399

SOUTH KAIPAROWITS TO MILFORD ROUTE

	Total Impact	Beaver City	Miners-ville	Milford	Alton	Glen Canyon City	Kane County Area	Garfield County Area	Beaver County Area
1981	3,486	349	174	349	872	872	523	174	174
1982	3,908	391	195	391	977	977	586	195	195
1983	4,086	490	204	409	1,022	1,022	618	204	204
1984	4,223	422	211	422	1,056	1,056	633	211	211

SOUTH KAIPAROWITS TO CEDAR CITY ROUTE

	Total Impact	Hurricane	Fredonia	Kanab	Glen Canyon City	Kane County Area	Wash-ington County Area	Iron County Area	Arizona
1981	3,488	872	174	697	872	244	244	139	244
1982	3,908	977	195	782	977	274	274	156	274
1983	4,086	1,022	204	817	1,022	286	286	163	286
1984	4,228	1,056	211	845	1,056	296	296	109	296

SOUTH KAIPAROWITS TO PAGE ROUTE

Total Impact			Glen Canyon City	Kane County Area	Arizona (County Area)
1981	2,611	1,958	326	326	
1982	2,928	2,196	366	366	

TABLE 4-14

PREDICTED NOISE IMPACT FROM DEVELOPMENT OF COAL RESOURCES

		Predicted Noise Level Ranges dBA Distance from Source			
Activity	Source/Distance	500 ft	1000 ft	1/2 mile	1 mile
Mining, Construction	85-90/50 feet	65-75	59-69	51-61	45-55
Pipeline Operation pumping island	86-90/5 feet	46-50	40-44	32-36	26-30
Rail Engine	86-96/100 feet	76-86	71-81	64-74	58-68
Rail Car (40 mph)	80-86/100 feet	68-74	62-68	53-59	48-54
Truck	85-90/50 feet	65-75	59-69	51-61	45-55

Source: VTN Consolidated, Inc. 1977; and U.S.E.P.A. 1975.

like to see some growth because of the potential economic benefits; however, they oppose significant changes in their local lifestyles. Both changes would occur with this alternative. For some, the positive benefits would outweigh the negative; however, for others the opposite would occur.

The south corridor, involving railroad construction from South Kaiparowits through Corridor Segment C18 would impact most heavily on Glen Canyon City. Glen Canyon City is made up largely of trailers and mobile homes left over from the construction of the Glen Canyon Dam. New growth would be greeted most favorably by local residents and the impacts of growth on local lifestyles would not be nearly as visible as would be the case in the small, stable, homogeneous communities that otherwise characterize this part of Utah.

Noise

The primary noise from trains comes from the engine exhaust and car wheel noise. The magnitudes and duration of the noise are functions of train speed, grade, and track condition. Measurements indicate that for any speed, 93 dBA is an appropriate noise level for the moving engine. There is a 6 dBA increase in overall car noise for each doubling of train speed. At 40 miles per hour, car noise at 50 feet would be between 85 and 90 dBA. Track conditions including bridges, joints, and wheel irregularities add to the noise of passing trains. These levels would only be significant under the high scenario and are discussed in more detail in that section.

The predominant continuing noise sources for operation of a coal slurry pipeline are expected to be the crushers at the load point and the pumping stations along the pipeline. Measurements made of high capacity electric pumps indicate sound levels between 80 and 90 dBA at 5-foot distances. Proposals for engine-driven pumps would add the engine noise terms to these values. Noise levels from slurry pipeline operation are not expected to be significant.

Predicted noise levels in various modes of transportation are summarized in Table 4-14. Additional information on noise can be found in the Air Quality Technical Report.

OVERALL IMPACTS OF COAL DEVELOPMENT

Overview

This section describes the total impact of each coal development scenario. The scenarios are as follows:

- Coal Production of 5 MTY and Truck Haulage
- Coal Production of 54 MTY, Slurry Pipelines, and Railroad
- Coal Production of 84 MTY, Slurry Pipeline, and Railroads

The examination of the impacts resulting from each level of coal production and an appropriate mix of transportation facilities has resulted in an analysis of cumulative impacts for each scenario. Since specific coal transportation routes and destinations have not been designated for the three coal production scenarios, transportation impacts for many resource elements are in summary form with reference made back to the previous section.

An attempt has been made to present impact analyses by environmental element for each scenario. However, following completion of the impact analysis it was noted that with the exception of the size of the disturbance, the impacts associated with some resource elements were basically the same for all scenarios. When the type of impact did not change, reference was made to the appropriate scenarios where the impacts were initially described.

This section also identifies various suggested mitigation measures which would reduce potential adverse environmental impacts. In most cases it was not possible to identify site-specific impacts. Therefore, most of the mitigation measures that have been identified are generic and would be further refined during the planning process. At the time site-specific proposals are reviewed, the effectiveness and practicality (legal, political, and economic) of specific mitigation measures would also be evaluated. In some cases specific types of impacts were identified which did allow for the development of specific mitigation measures. It should be noted that the mitigation measures identified by the ERT project team have not been committed to by any lease holder or transportation company. Mitigation measures adapted from BLM Manual Section 2063, Appendix 3, entitled "Stipulations for Land Use Authorization" are presented in Appendix I as examples of the types of measures usually required by the BLM in leases and right-of-way permits.

Low Scenario: Coal Production of 5 MTY and Truck Haulage

Air Quality

Specific Assumptions and Analysis. In order to interpret properly the air quality modeling results presented in this section, it is important to understand the modeling approach and the assumptions which were used. The air quality analysis was designed as a generic study which would identify possible problem areas and establish the relative impacts which would result from combinations of the variables previously described in the assumptions. Two scales of modeling were considered: local scale to assess site-specific impacts on air quality standards resulting from mining activities, coal transportation along specified corridors, and induced growth in selected population centers; and regional scale to assess the cumulative impact of mining, coal transportation and region-wide population expansion on regional air pollution levels and regional visibility. No project-specific mining plans were incorporated in the analysis; however, best engineering practice and assumptions were used. Results are presented so that once specific mining or transport proposals were submitted, the results would be easily applied to identify worst-case impacts for that action.

The ERT Air Quality Technical Report provides detailed projected emissions inventories by which specific proposals can be related to the assumptions used in the modeling. The modeling results must be interpreted in light of the following important considerations:

1) Twenty-five ton haul trucks have been assumed for in-mine coal transport. If 150-ton trucks were to be used, for instance, projected haul road emissions would be effectively mitigated by a factor of 5 or greater. Haul road lengths varying from 10 to 20 miles, one way, have been assumed for the lease areas. Differences from these values in an actual application would significantly alter the potential impacts.

2) Unmitigated emissions for mining and transport sources assume no emission control except watering on unpaved mine haul roads. Watering was included because the haul road emission factor used in this analysis included the effect of watering. This emission factor was developed from measurements taken at several different mines during actual hauling operations with regularly scheduled watering programs (PEDCo 1978).

3) Mitigated emissions include an overall dust control of 88 percent at the mines on both the local and regional scale. In addition, regional mitigated emissions include the reduction of rural unpaved road emissions by 85 percent in two counties and reduction of coal transportation emissions by 90 percent.

4) Concentrations calculated in the local modeling analysis are based on a sector-average plume model which used both actual annual average meteorology and worst-case, site-specific (low wind speed, stable) hourly meteorology. These worst-case conditions are expected to occur about 40 percent of all annual hours. For particulate emissions, a single particle deposition speed was incorporated in the model (2 centimeters/second), but changing particle size distribution as the dust plume moves downwind was not modeled directly, with the result that beyond about 10 kilometers, deposition is overestimated and the large scale regional model results should be consulted.

5) The local modeling revealed that for mine-related dust sources, peak concentrations near mining activities are reduced by a factor of 10 in a distance of 5 to 15 kilometers downwind from the source in both short-term and annual cases. Because individual property lines were not specified in this study, it was necessary to assume distances from sources to property boundaries and to Class I areas. In evaluating NAAQS and PSD Class II increments which are applicable at the property lines, peak modeled concentrations at the mines were reduced by a factor of 3, implying a 3-kilometer average separation. (Peak concentrations were evaluated directly for transportation corridor sources.) In evaluating PSD Class I areas, peak concentrations were reduced by a factor of 10 for the Alton lease area (implying a separation from Bryce Canyon of 5 to 15 kilometers) and by a factor of 30 for the North and South Kaiparowits lease areas (reflecting

much larger separation distances for these cases).

6) Regional concentrations of fine particulates and gases were calculated for a 72-hour period for three seasons, using meteorology matching known high pollution episodes for the region. The visibility analysis used data from the worst (afternoon) hour. The air quality analysis used the 24-hour average concentrations for the last day. A diagnostic winds model incorporating topographic flows and a sequential mesoscale puff dispersion model were used to calculate the regional concentrations. Only very fine particulates ($<3\mu$) were evaluated directly, using a deposition velocity of 0.1 centimeters/second. NO_X, SO_2 and SO_4 were also modeled for each scenario.

7) The regional concentration values presented in the preceding paragraphs are based on worst-case (for TSP) meteorology during the summer when regional visibility is poorest because of higher humidity and lighter winds. A comparison of the worst regional meteorology by season indicates that the area affected by each coal lease area is roughly equal for all seasons, a reflection of the fact that only a small fraction of the projected sources are wind-speed dependent and higher winds tend to cause narrower, but longer, dust plumes. The highest regional scale concentrations occur during the fall when light winds prevail. The South Kaiparowits area is the most seasonally varying because it is more exposed to changes in regional wind. The limiting numbers used for air quality standards evaluation, on the other hand, were based on local low wind speed, stable conditions which might occur through all seasons (about 40 percent on an annual basis), or were based on annual climatic characteristics.

8) Most dust particulates are large and settle out relatively rapidly. Visibility, however, is most affected by very small particulates in the range from 0.1 to 1 μ diameters which remain aloft for long periods. Measured particle size data were used to establish fractions of TSP less than or equal to 3 μ. These fine particulates, called RSP (Respirable Size Particles) were assumed to comprise about 30 percent of all dirt road and agricultural dust, about 94 percent of diesel exhaust smoke particles, and about 3 percent of coal blow-off dust. Only RSP emissions were used in the regional scale analysis because, generally, only these smaller particles could be transported long distances to affect air quality and visibility across the study region.

9) Other significant details of the modeling are explained in the Air Quality Technical Report (ERT 1980), Chapter 5.

Impacts. In the low (5 MTY) scenario, projected unmitigated mine, transport, and urban emissions would not result in the violation of any air quality standards for any pollutant except total suspended particles (TSP). On the local scale, unmitigated mine emissions from the Alton lease area would exceed the annual PSD increments for Class I and Class II TSP at Bryce Canyon and the mine boundary by factors of two, and would exceed the 24-hour increments by a factor of 5 (Table 4-15). Unmitigated coal blow-off from North Kaiparowits coal lease area truck traffic would be within 10 percent, but not in excess of, the allowable PSD Class I increment on Utah Route 12 in Bryce Canyon. Unmitigated blow-off from Alton and South Kaiparowits coal lease area truck traffic would be within 10 percent, but not in excess of, the allowable PSD Class II increment on US 89 between Johnson Canyon and Kanab (segment 89f).

The worst-case regional air quality would occur late in the lease life when urban areas reach maximum population. With 5 MTY coal development, regional TSP concentrations in Garfield and Piute Counties would increase by about 10 $\mu g/m^3$. Other locations in the study area would not change significantly, except locally near the mines. On the regional scale, the added contribution from the unmitigated sources at the Alton lease area would be about 40 $\mu g/m^3$ in an area extending as far north as Utah Route 12. The impact of the North and South Kaiparowits coal lease areas would be a doubling of ambient dust loading to 10 $\mu g/m^3$ northeast of the lease areas.

Regional RSP concentrations isopleths for the unmitigated emissions are presented in Figure 4-12.

Mitigation Measures. Implementation of mitigation measures would reduce the unacceptable air quality impacts and alleviate any potential air quality standards violation. Ap-

TABLE 4-15
COMPARISON OF CALCULATED CONCENTRATIONS[1]

	Unmitigated TSP Emissions ($\mu g/m^3$)							
	NAAQS				PSD Increments			
	Primary		Secondary		Class I		Class II	
Standards	Annual (75)	24-hr (260)	Annual (60)	24-hr (150)	Annual (5)	24-hr (10)	Annual (19)	24-hr (37)
Scenario								
Low								
Alton	34	185	34	185	10	55	34	185
N. Kaiparowits	5	10	5	10	1	1	5	10
S. Kaiparowits	5	32	5	32	2	3	5	32
Medium								
Alton	155	831	155	831	47	249	155	831
N. Kaiparowits	71	149	71	149	7	15	71	149
S. Kaiparowits	75	474	75	474	7	47	75	474
High								
Alton	155	831	155	831	47	249	155	831
N. Kaiparowits	142	298	142	298	16	30	142	298
S. Kaiparowits	112	710	112	710	11	71	112	710

Source: ERT Project Team
[1]Based on modeling results of coal mining, including effect of particle deposition

pendix J, which contains section 7 of the ERT Air Quality Technical Report (1980), represents a comprehensive list of mitigation measures which could be incorporated to achieve accept able air quality impacts in conjunction with coal development.

Mitigation measures selected for mining operations are based on the local modeling results and include:

- an increase in the size of haul trucks from 25 tons to 150 tons;
- chemical stabilization of the coal haul roads;
- enclosure of the coal dump hopper at the processing facility, including a negative pressure device;
- enclosure of the coal surge pile with venting through a fabric filter system (baghouse);
- water spray grader and scraper activities during the construction and revegetation operations;
- enclosure of crusher operations with venting through a fabric filter system (baghouse); and
- dust collection hoods for the mining drill.

Except for the chemical stabilization of the haul road surfaces, all of these methods are generally used at large surface coal mining operations, though not necessarily for the prevention of adverse air quality impacts. Some are simply standard engineering practice or are done for safety reasons. For example, enclosing the coal surge pile and crusher facility and venting through a baghouse ensures that, from an engineering standpoint, product loss will be minimized. Also, most of the state regulatory agencies in the west currently require some or all of these measures as best available control technology during the permitting process. The use of chemical stabilizers on haul roads is rapidly becoming a standard regulatory requirement and is currently undergoing studies by both industry and government. However, the technology for chemical control of dust emissions from unpaved roads at surface mining operations already exists.

These combined mitigation measures would be effective in reducing the unmitigated particulate emissions from the three mining operations at least by 88 percent. The effect on particulate emissions resulting from mining operations at each lease area is shown in Table J-7 in Appendix J.

On the regional scale, additional mitigation measures applied outside of the mine lease areas were found to be necessary to achieve acceptable air quality levels. These additional measures include:

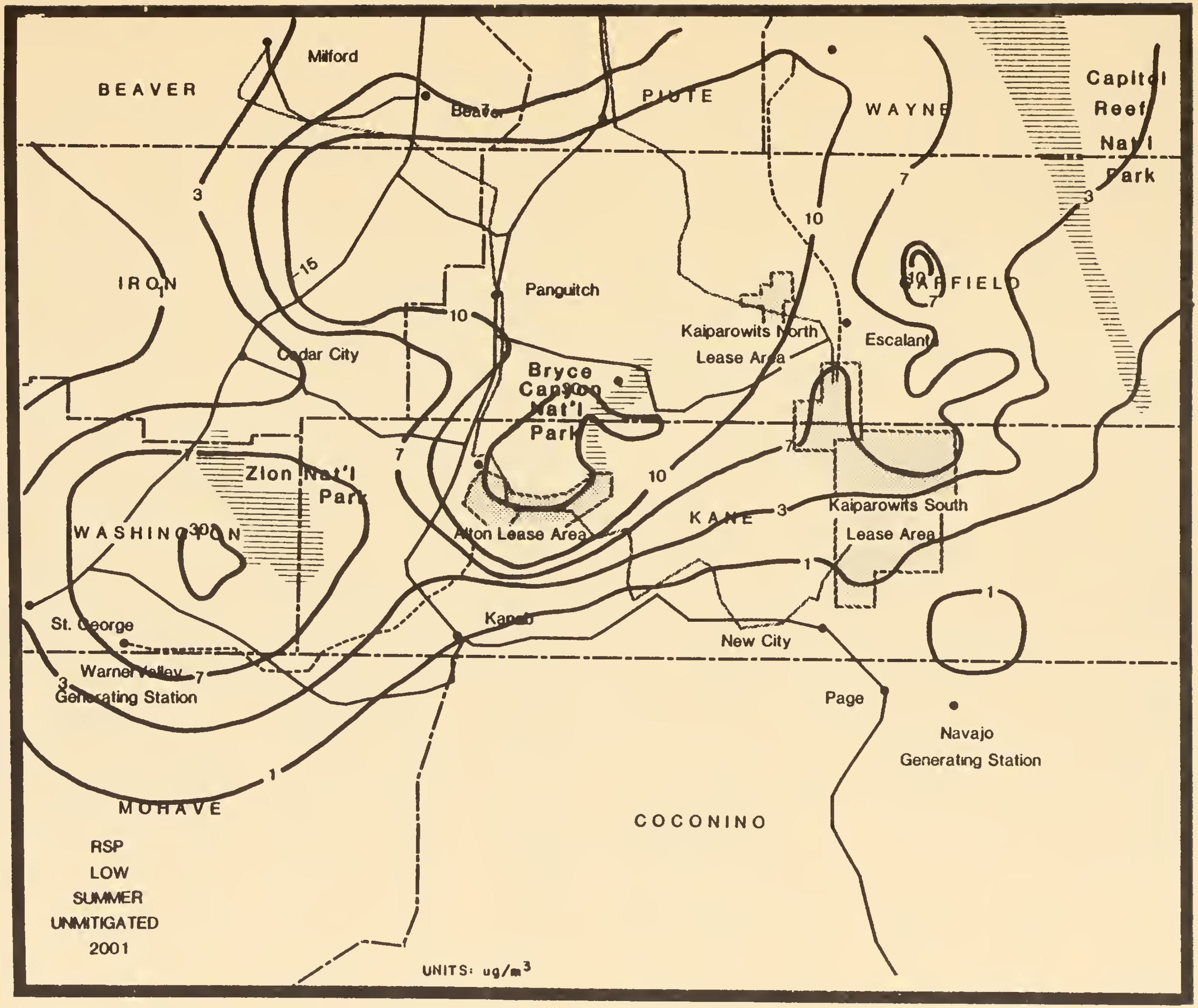


Figure 4-12. Low Production RSP Concentrations Isopleths (Unmitigated).

TABLE 4-16
COMPARISON OF CALCULATED MITIGATED EMISSION CONCENTRATIONS[1]

Mitigated TSP Emissions ($\mu g/m^3$) (88% reductions from unmitigated value)

Standards	NAAQS				PSD Increments			
	Primary		Secondary		Class I		Class II	
	Annual (75)	24-hr (260)	Annual (60)	24-hr (150)	Annual (5)	24-hr (10)	Annual (19)	24-hr (37)
Scenario								
Low								
Alton	4	22	4	22	1	7	4	22
N. Kaiparowits	1	1	1	1	<1	<1	1	1
S. Kaiparowits	2	4	1	4	<1	<1	1	4
Medium								
Alton	19	100	19	100	6	30	19	100[2]
N. Kaiparowits	9	18	9	18	1	2	9	18
S. Kaiparowits	9	57	9	57	1	6	9	57[3]
High								
Alton	19	100	19	100	6	30	19	100[2]
N. Kaiparowits	17	36	17	36	2	4	17	36
S. Kaiparowits	13	85	13	85	1	9	13	85[4]

Source: ERT Project Team

[1]Based on modeling results of coal mining, including effect of particle deposition

[2]Additional mitigation measures would have to be incorporated to reach the 94% reduction level to meet the Class I and Class II air quality standards.

[3]Additional mitigation measures would have to be incorporated to reach the 91% reduction level to meet the Class I and Class II air quality standards.

[4]Additional mitigation measures would have to be incorporated to reach the 96% reduction level to meet the Class I and Class II air quality standard.

- reduction of approximately 85 percent of the county unpaved road emissions in Garfield and Kane Counties through paving of the most heavily traveled rural roads;
- revegetation of transportation corridors concurrently with construction; and
- spraying loaded coal with an emulsive binder to reduce coal blow-off emissions from loaded haul trucks traveling along transportation corridors by 90 percent.

The regional emission reduction for the low scenario is summarized in Table J-8 in Appendix J. Pavement of some county roads would probably be a direct result of county growth in conjunction with coal development. It is assumed here that pavement of the most heavily traveled roads combined with a change from rural to urban lifestyles would result in an emission reduction of approximately 85 percent. The use of chemical binders on loaded rail cars is common in many coal transport situation and could be easily adapted to trucks. In general, the primary reason for reducing coal blow-off is to prevent product loss. Revegetation of transportation corridors as construction proceeds is a good management practice for dust control along transportation routes.

The resulting TSP concentrations for the low development scenario would not adversely affect the local air quality and would not violate any Federal or state ambient air quality standards or PSD increments near the mine lease areas (Table 4-16). Regional RSP concentrations for the mitigated emissions are presented in Figure 4-13. Similar to the local modeling results, regional concentrations are well below ambient standards and PSD Class I and Class II increments are not exceeded.

Visibility

Specific Assumptions and Analysis. Visibility impacts resulting from the three coal development scenarios were calculated by means of a visual range and discoloration model which used the regional concentration fields of the air quality model as impact. Of the seven vistas evaluated in the Air Quality Study, (shown in Figure 3-1), only three were shown to have potential visibility degradation due to coal-related activity. These are:

(1) Lava Point in Zion National Park NE to Bryce Point in Bryce Canyon National Park

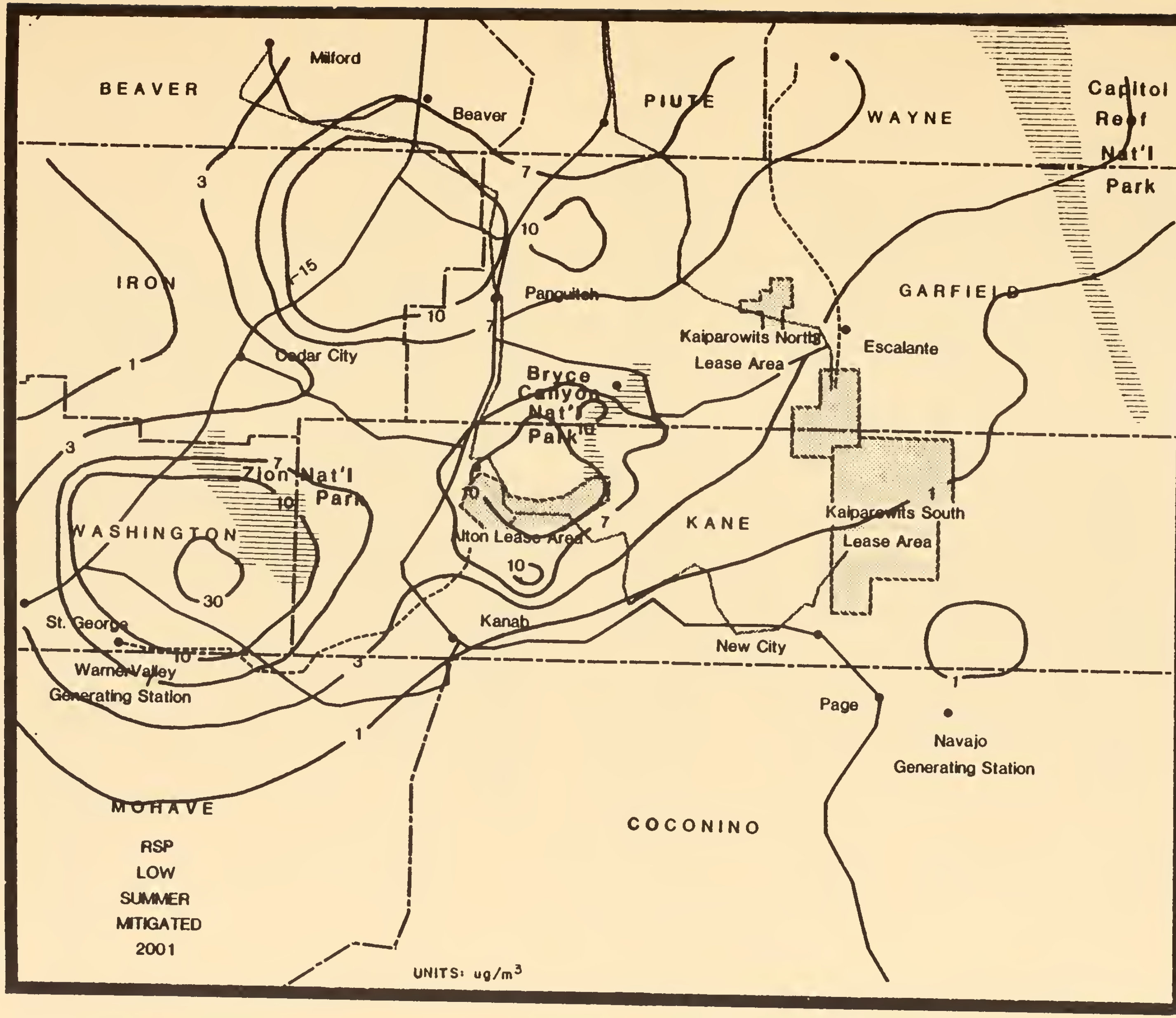


Figure 4-13. Low Production RSP Concentrations Isopleths (Mitigated).

4-17

BRYCE POINT TO NAVAJO MOUNTAIN VISTA
MEAN GEOMETRIC VISUAL RANGE EXCEEDING[1] BASELINE VALUE
(km)

	Baseline Non coal 2001	Unmitigated			Mitigated[3]		
		5 MTY	54 MTY[2]	84 MTY	5 MTY	54 MTY[2]	84[4] MTY
Exceeding 10% of the time	310	305	210	110	310	285	285
Exceeding 50% of the time	200	188	109	49	200	177	177
Exceeding 90% of the time	127	116	56	22	127	105	105

Source: ERT Project Team

[1]most probable

[2]construction phase

[3]assumes 88% reduction in mine sources emissions, paving 3/4 of heavily used rural roads in Kane and Garfield Counties, and 90% control on coal transport emissions.

[4]low and high scenario values pertain to the operations phase late in the coal lease life; the medium scenario values pertain to the initial construction period.

TABLE 4-18

NUMBER OF DAYS PREDICTED VISUAL RANGE WOULD EXCEED THAT SHOWN IN THE ACCOMPANYING PHOTOGRAPHS[1]

	Baseline	Low Scenario Production		Medium Scenario Production		High Scenario Production	
	2001	Unmitigated	Mitigated	Unmitigated	Mitigated	Unmitigated	Mitigated
Photo 1 Excellent	11	9	11	2	6	0	6
Photo 2 Good	57	50	57	15	45	2	45
Photo 3 Fair	87	84	87	47	83	10	83
Photo 4 Poor	90	90	90	74	90	28	90

[1]Assumes a "season" of 90 fair, summer days.

(Accompanying Photographs) ▶

(2) Bryce Point SE to Navajo Mountain east of Page, Arizona, and

(3) Bryce Point north to Langdon Peak and Parker Mountain in eastern Piute County

The vista from Hopi Tower in Grand Canyon National Park northwest toward Mt. Trumbull is upwind of potential degradation for all meteorological scenarios. The vista from Lava Point south to Mt. Trumbull would be impacted by the plume from the Warner Valley Power Plant, but not from the potential coal development activities.

The reported visibilities in this section are dependent upon the relative geometry of the sun, plume, and observer. Using a set solar hour enables one to compare various scenarios for a given vista. However, the separate vistas should not be compared for the same scenario except to note that visibilities would be greatly decreased when facing the sun; would be comparable for cross-lit plume conditions where sun, plume, and observer were in similar angular relationships; and would be better when looking away from the sun.

The definitions of "mitigated" and "unmitigated" are the same as provided for in the Air Quality Assumption and Analysis Section. In addition, mitigation measures for the scenarios would be the same as described in the Air Quality section.

Impacts. In the low (5 MTY) scenario, no significant visibility degradation is anticipated for the Bryce Point to Navajo Mountain vista for either mitigated or unmitigated source conditions (Table 4-17). As noted in the Future Environment section, the Lava Point (in Zion National Park) to Bryce Point vista would be heavily impacted by fine particles from the Warner Valley Power Plant but not from potential coal development activities. The visibility decreases only 5 kilometers (3 miles) in mean geometric visual range when comparing the low and high development scenarios for the year 2000, but decreases about 50 percent from present values after installation of the power plant.

None of the other vistas would be affected.

Photographic Presentation of Visual Impacts. It is difficult to determine or interpret the significance of potential visibility changes as a result of potential coal development. Therefore, an attempt has been made to show the relationship of the regional visibility modeling results to selected photographs which represent existing conditions in the study area. A series of four photos were taken from Bryce Point looking southeast to Navajo Mountain east of Page, Arizona (130 kilometers or 81 miles). These photos represent different visual ranges that are observed under present conditions. The frequency of occurrence of visual range represented in the photographs is dependent upon regional air quality and meteorological conditions and is noted in Table 4-18.

The first three photographs are representative of the range of existing visibility in the area. However, Photograph 1, showing the best visibility, does not indicate the true clarity of the air. Under conditions shown in Photograph 1, a visitor at the vista could distinguish finer detail than is shown in the photograph.

The two photos showing reduced visual range (Photographs 2 and 3) may not adequately illustrate the potential visual appearance for the calculated impact. These photographs do not show a separate dark haze layer which might be obvious to an observer. Given proper lighting conditions this layer might appear brownish as well. These considerations are important in using these photographs to evaluate the projected impact of coal development in the study area.

The conditions shown in Photograph 4 are expected to occur less than 1 day in a 90-day season. It should be noted that the reliability of calculating frequency of occurrence of such rare events is very low. This is especially true since only one summer season of existing data was available. Also, the widespread haze conditions shown in Photograph 4 may have been caused by natural fires or transport of a polluted cloud into the region. These conditions were not included in the modeling.

The results of the regional visibility modeling can be correlated with these photographs to illustrate the potential visual range and frequency of occurrence for various levels of development. To assist the reader in understanding the relationship between the photographs and table, it is necessary to include some explanatory text. Table 4-18 summarizes the number of days the predicted visual range for the baseline and the levels of coal development would *meet* or *exceed* the visual range shown in each photograph (this would *only* be for the summer season of 90 days).

It is important to interpret this information carefully because the table basically shows the changes in frequency of occurrence of the visual ranges represented in the photographs. Additional explanatory text for Photographs 1, 2, and 3 follows:

Photograph 1

Baseline (2001

The visual range would be comparable to, or better than, the visual range shown in Photograph 1 for 11 days out of the summer period without coal development.

Low Coal Production (mitigated)

The visual range would be comparable to, or better than, the visual range shown in Photograph 1 for 11 days out of the summer period.

Medium and High Coal Production (mitigated)

The visual range would be comparable to, or better to than, the visual range shown in Photograph 1 for 6 days out of the summer period.

Photograph 2

Baseline 2001

The visual range would be comparable to, or better than, the visual range shown in Photograph 2 for 57 days out of the summer period without coal development.

Low Coal Production (mitigated)

The visual range would be comparable to, or better than, the visual range shown in Photograph 2 for 57 days out of the summer period.

Medium and High Coal Production (mitigated)

The visual range would be comparable to, or better than, the visual range shown in Photograph 2 for 45 days out of the summer period.

Photograph 3

Baseline (2001)

The visual range would be comparable to, or better than, the visual range shown in Photograph 3 for 87 days out of the summer period without coal development.

Low Coal Production (mitigated)

The visual range would be comparable to, or better than, the visual range shown in Photograph 3 for 87 days out of the summer period.

Medium and High Coal Development (mitigated)

The visual range would be comparable to, or better than, the visual range shown in Photograph 3 for 83 days out of the summer period.

Additional information on the relationship between the photographs and levels of coal development can be found in Figures B-2, B-3, and B-4 in Appendix B. Detailed methodology on visibility analysis and frequency of occurrence is included in the Air Quality Technical Report.

Topography, Geology, and Minerals

Impacts. The most significant impact to minerals would be the nonrecovery of coal, that is, coal would be left in the ground as a result of mining and would not be recoverable with current technology. The amount of coal left in the ground would be almost 50 percent in the underground mines and about 6 percent in the surface mines. This would amount to 3 MTY in the underground mines and 0.13 MTY in the surface mines. In underground mines this would be due to the following (U.S.D.I. 1979): (1) Coal is left in pillars and barriers to prevent collapse, (2) beds are either too thin or too thick to be mined safely or for economic reasons, and (3) multiple beds of coal that are too close together to be safely mined.

The topography would be modified due to surface mining in the Alton lease area. Change in the mined area would include cutting highwalls up to 150 feet high and the creation of spoil piles up to 225 feet high (Figure 2-1). Spoil piles would be reshaped during reclamation. A significant impact caused by underground mining would be subsidence of the land surface over the mined area. The surface area affected by subsidence would range from 90 to 130 percent of the area mined (U.S.D.I. 1979). The amount of subsidence would range from a maximum in the center of the mined areas to a very small amount in the peripheral areas. Maximum subsidence would be from 50 to 90 percent of the thickness of the coal that is removed. The results of subsidence reflected at the surface include: (1) open and closed fractures, (2) buckled and bulged bedrock, and (3) sinkholes and other depressions (Dunrud 1976). In areas where coal is mined beneath cliffs or in steep canyons, rockfalls and small landslides may be expected (Dunrud et al. 1976). However, the area thus affected would probably be only a few acres.

The volume of limestone needed for rock-dusting in the underground mines would be 0.016 MTY. Wherever coal is mined, coal bed fires may start. These are caused by spontaneous combustion and lightning. The amount of coal that may be lost in this manner cannot be quantified.

There is speculation that blasting operations in the Alton lease area could harm the unusual erosional rock formations in Bryce Canyon National Park. The magnitude of this impact is not known at this time. However, the National Park Service has contracted a study of this potential problem aimed at determining whether blasting can be performed and what constraints would be necessary to protect the features of Bryce Canyon National Park.

Mitigation Measures. Impacts to topography as a result of development of surface mines would be partially mitigated. Upon completion of surface mining in the Alton area, the mined area would be contoured to reflect the original land surface in accordance with the Surface Mining Control and Reclamation Act of 1977. Other site specific mitigation measures required by BLM can be found in Appendix I.

Soils

Impacts. Soils in the coal production areas would be impacted through mechanical handling and mixing during the topsoil stripping and stockpiling operations for surface mines and during the construction of ancillary facilities for both surface and underground mines. Approximately 4,992 acres would be disturbed on the coal lease areas under this production level scenario. Surface-mined pits would be backfilled and recovered with the stockpiled topsoil as mining progresses, therefore, many of the soil impacts must be considered short- term. An additional 1,111 acres of land would be consumed as a result of urban expansion in the region's existing communities (Table 4-27). This land is not expected to be reclaimed. Reclamation procedures enforced by the Office of Surface Mining would reduce long- term impacts to soils. Increased population in the region resulting from coal development would increase construction of roads, housing, and other community facilities as well as increase off-road vehicle use causing slight long-term impacts to soil productivity.

Mitigation Measures. Impacts to soils could be mitigated by imple mentation of the following mitigation measures:

- Topsoil taken from disturbed areas should be stockpiled and utilized during reclamation.

- Conduct construction activities to minimize or prevent degradation of soil conditions in areas where soil erosion would result.

- Follow Office of Surface Mining (OSM) guidelines for reclamation.

Water Resources

Impacts. The following impacts to water resources were delineated in the Southern Utah Regional EIS (U.S.D.I., Geological Survey 1979).

"Surface runoff may be diverted into cracks because of subsidence and subsequent cracking. The quantity of water that might be so diverted, if any, cannot be predicted, but it could not exceed the average annual runoff from the areas involved and would probably range from zero to one-fourth of the annual areal runoff. Water so diverted into the ground would not be lost but would add to ground-water storage and would eventually be discharged elsewhere in the same drainage.

Mining that drains water from coal beds or saturated beds above the coal would cause local water-level declines, and change the direction of ground-water flow near the mine. Subsidence and associated cracking could possibly drain saturated sandstone beds above extracted coal and thereby increase recharge to lower beds. Less than one-half of the mining at each proposed site would be in or below saturated beds and might therefore affect ground-water flow. Accordingly, the amount of ground water and saturated sand stone that would be affected is very small—less than one-tenth of 1 percent of that in the region. Formations and possible saturated sandstone that would be disrupted in the Kaiparowits Plateau would include the John Henry and Drip Tank Sandstone Members of the Straight Cliffs Formation and the Wahweap Formation; those in the Alton area would include the Dakota Sandstone and alluvial deposits.

The chemical quality of the water is not likely to be affected by drainage of acid waters from mines because, (1) the sulfur content of the coal is low, generally less than 1 percent, (2) the quantities of water and rates of water movement associated with the coal and the overburden material are small—average is less than 40 acre-feet per year per square

mile—and (3) most of the water in the study area is highly alkaline—concentrations of bicarbonate are 100-300 mg/L, which would buffer acidity. A recent study of mine drainage and water quality in Colorado shows essentially no coal-mine drainage problems, which is attributed mainly to the low sulfur content of western coal (Wentz 1974).

The chemical quality of water in the strip-mine area near Alton would deteriorate owing to leaching from disturbed material. Contamination would consist mainly of increased concentrations of sodium, sulfate, and nitrate. Effects on ground water would be restricted to the mined area, as little water movement is expected through the replaced overburden. The concentration of dissolved solids in runoff from the mined area may increase as much as 10 percent, based on data from Black Mesa, Ariz. (Verma 1977); this increase would have little effect locally and would probably be imperceptible in flows to the Colorado River because the mined area is less than one-half of one percent of the total watershed involved. Sediment movement from spoil piles may cause local increases in sediment loads in tributaries of Kanab, Skutumpah, and other washes directly intercepted by strip mining. However, increased sediment movement to the Colorado River would be insignificant (less than 0.2 of 1 percent) because the source area (the spoil piles) at any given time would be extremely small compared to the total contributory areas of Kanab Creek or the Paria River.

Mine drainage may contain concentrations of trace elements, particularly arsenic, iron, manganese, and selenium, slightly greater than normally found in natural streams of the region, as in some coal mines in central Utah, based on unpublished data from Southeastern Utah Association of Governments, 208 Water Quality Program, 1977. However, quantities of mine drainage would be small—probably less than 10 acre-feet per year—and reasonable enforcement of mitigations regarding effluent standards should prevent any contamination of streams and aquifers. Water pollution from mine facilities, such as storage and loading areas, tailing ponds, waste piles, and conveyor belts, will be prevented by adequate enforcement of Utah effluent standards and limitations."

Water requirements for low level coal production would be minimal, with no significant impacts on regional water availability.

Mitigation Measures.

- Store petroleum products, chemicals, and toxic or volatile materials in durable containers or impermeable containment structures. This storage should be such that any accidental spillage would not drain into any watercourse.

- Locate equipment service areas away from streams to prevent potential water contamination.

- Locate roads out of stream bottoms, if possible, to minimize sediment entering stream channels.

- Protect resource values by maintaining water and sediment control structures during and after the operation. If sediment movement problems occur during the operation, construct appropriate sedimentation basins.

- Avoid channeling water into drainages not capable of handling the added flow.

Vegetation

Impacts. An estimated 4,992 acres would be removed from vegetation production in the mining areas over the project period (Table 4-19). This would result in an estimated loss of 181 animal unit months (AUMs) per year from mining areas. Assuming that thirteen years would be required before livestock could be allowed back on these areas, a total of 2,353 AUMs would be lost at this level of production over the life of the projects. The allotments contained in the Escalante, Paria, and Zion Planning Units (USDI BLM 1980) include the three coal lease areas under consideration. There are 54,352 AUMs per year available on Federal lands within these three planning units (USDI, BLM 1980). The estimated 181 AUMs per year lost from mining areas represent less than 1 percent of the available Federal AUMs in the three planning units. Expansion of existing communities will consume an additional 1,111 acres of land (Table 4-27). AUMs lost as a result of this expansion are unquantifiable however, land use surrounding the regions communities is often agricultural or otherwise highly productive relative to the region as a whole.

Impacts to threatened or endangered species are not quantifiable because the exact location of mining areas are not presently

TABLE 4-19
ESTIMATED VEGETATION COVER TYPE AND AUM LOSSES FOR DIFFERENT COAL DEVELOPMENT SCENARIO ON THE COAL LEASE AREAS

Alton Lease Area

	Coal Production (MTY)					
	2		9		9	
Cover Type	Acres lost	AUMs lost[1]	Acres lost	AUMs lost	Acres lost	AUMs lost
Pinyon-Juniper	3,069	102	7,787	260	7,787	260
Sage-Grass	394	20	999	50	999	50
Mountain-Brush	236	16	599	40	599	40
Barren	79	—	199	—	199	—
TOTAL	3,778	138	9,584	350	9,584	350

North Kaiparowits Lease Area

	Coal Production (MTY)					
	1		15		30	
Cover Type	Acres lost	AUMs lost	Acres lost	AUMs lost	Acres lost	AUMs lost
Pinyon-Juniper	365	12	4,026	134	6,251	208
Ponderosa-Pine	123	8	1,355	90	2,105	140
TOTAL	488	20	5,381	224	8,356	348

South Kaiparowits Lease Area

	Coal Production (MTY)					
	2		30		45	
Cover Type	Acres lost	AUMs lost	Acres lost	AUMs lost	Acres lost	AUMs lost
Pinyon-Juniper	496	17	2,989	100	3,843	128
Desert Shrub	230	6	1,384	35	1,780	45
TOTAL	1726	23	4,373	135	5,623	173

[1]Assumptions: Pinyon Juniper = 30 acres/AUM
Ponderosa Pine = 15 acres/AUM
Mountain Brush = 15 acres/AUM
Sagebrush-Grass = 20 acres/AUM
Desert Shrub = 40 acres/AUM

Cumulative Coal Production

	Coal Production (MTY)					
	5		54		84	
Cover Type	Acres lost	AUMs lost	Acres lost	AUMs lost	Acres lost	AUMs lost
Sage-Grass	394	20	999	50	999	50
Mountain Brush	236	16	599	40	599	40
Desert Shrub	230	6	1,384	35	1,780	45
Ponderosa Pine	123	8	1,355	90	2,105	140
Pinyon Juniper	3,930	131	14,802	494	17,881	596
Barren	79	—	199	—	199	—
TOTAL	4,992	181	,338	709	23,563	871

known. Based on available information on the presence of candidate species on the coal lease areas, the chances that surface mining would disturb populations of rare plant species is considered low. One species is known to occur in one of the three coal lease areas (Map 3-4). The risk of disturbance increases with the area disturbed. However, even a small disturbance may have significant effects on small populations of plants. It is assumed that the relatively small area disturbed in this scenario constitutes a small impact risk to rare plants, especially if mitigation procedures are employed.

Mitigation Measures. The following mitigation measures could be implemented to mitigate vegetation impacts on surface disturbances of any size.

Threatened and Endangered Species.

- Avoid habitats containing populations of rare species by conducting thorough searches prior to mining or corridor centerline routing.
- Establish new populations or relocate existing populations if feasible. The relocation option is limited because of the highly specific ecological requirements of most species.

Revegetation of Disturbed Lands and Range Improvements

- Increase the carrying capacity of lands with low current productivity to compensate for area losses due to surface disturbances. Range improvement programs including chaining or uprooting undesirable plant species and replacing them with species more palatable to livestock. The BLM (1980) has suggested that available livestock forage may be more than doubled by implementing range improvement programs in the Paria, Escalante, and Zion Planning Units. Other techniques for improving range utilization are developing new water sources to disperse animals over a wider area, and to regulate livestock movements with more fencing.

Range improvement programs contribute impacts to other ecosystem components such as wildlife, soils, and surface and groundwater flows. These improvement programs must be planned carefully to insure that compensation for livestock losses is not offset by damage to other components.

- On mined areas or transportation corridors, the following minimum requirement should be considered in developing revegetation plans:

  a. Salvage topsoil suitable as a growth medium. In the absence of suitable topsoil, mined overburden strata suitable for revegetation should be applied to the surface of reclaimed areas.

  b. Plant revegetation species adapted to the region. The species mixture should include grasses, broadleaf herbaceous species especially legumes and shrubs. Native species should be used but availability of seed may be limited. Some species in the mixture should be selected that establish rapidly to reduce soil erosion. Shrubs that germinate poorly may require establishment as seedlings in containers.

  c. Design slopes on reclaimed areas to be generally 3:1 or less. The area of cool slope exposures (north) should be maximized in designing graded spoils.

  d. All areas that have been seeded should be covered with a straw, wood fiber, or hydrocarbon binder.

  e. Irrigate acres that lie within very low annual precipitation zones (10 inches or less) to initiate germination and establishment.

  f. Protect reclaimed areas from livestock with fencing.

  g. Monitor revegetation success periodically to determine whether reseeding is required and to determine whether productivity has reached priming levels.

Other Concerns.

- Protect riparian zones included in drainages leading away from mining areas by monitoring surface flows through those drainages.

- Restrict off-road vehicle use to prevent unnecessary compaction and vegetation disturbance.

- Consider underground mining in areas where topsoil is lacking or very poor, and overburden quality is too poor to support plant life.

Wildlife

Impacts. Wildlife impacts would result from destruction and modification of habitat and increased human activity in the region. Under this scenario, 4,992 acres of habitat would be lost on the coal lease areas, and an additional 1,111 acres lost due to expansion of existing communities (Table 4-27). Impacts would include: loss of food for herbivores (plant-eating animals), loss of cover, direct mortality of low mobility wildlife, displacement of mobile wildlife, and increased competition on adjacent unaffected areas. Table 4-20 quantifies the loss of various wildlife categories on coal lease areas at each level of development based on carrying capacities of occupied habitat.

Increased traffic (both coal trucks and personal vehicles) would increase wildlife highway mortality especially where highways bisect critical winter deer range (see Map 3-5). The significance of highway mortality would increase proportionately to the density, speed, and timing (wildlife are more active at certain times of day and year) of traffic where adjacent to wildlife populations. Under this scenario, reported deer mortalities in the region would be expected to increase by 105 deer per year, a 62 percent increase over current loss rates. An increase in raptor mortality would result from increased traffic and new utility lines. However, this impact cannot be quantified. If losses included the peregrine falcon or bald eagle, the impact would be of national significance.

Impacts to aquatic ecosystems could result from introduction of sediments or toxic materials. High sediment levels would reduce or eliminate aquatic life by smothering. Adult fish may tolerate high sediment levels, but their reproductive stages (e.g., eggs or sac fry) may be smothered in the same manner as aquatic insects. Most streams draining mine areas are intermittent and show the effects of erosion from the existing sparsely vegetated land surface. As a result, aquatic habitat is limited and already adapted to highly turbid conditions, and moderate additional sediment inputs would not result in significant impacts. In addition, good mining practice can largely control erosion through use of berms and runoff diversions. Revegetation of spoil areas would return mined areas to at least existing erosion levels, so long-term erosion impacts to aquatic systems should either be small or avoidable.

TABLE 4-20
MAXIMUM POTENTIAL LOSS OF WILDLIFE FROM HABITAT LOSS ON COAL LEASE AREAS[1]

Alton Lease Area			
	Coal Production (MTY)		
	2	9	9
Lost Habitat (acres)	3,778	9,584	9,584
Category of Wildlife	Number of Animals Lost or Displaced		
Deer	38	96	96
Large Predators	8	19	19
Game Birds	756	1,917	1,917
Small Mammals	18,890	47,920	47,920
Songbirds	9,445	23,960	23,960
Herpetofauna	9,823	24,918	24,918

North Kaiparowits Lease Area			
	Coal Production (MTY)		
	1	15	30
Lost Habitat (acres)	488	5,381	8,356
Category of Wildlife	Number of Animals Lost or Displaced		
Deer	5	54	84
Large Predators	1	11	17
Game Birds	98	1,076	1,671
Small Mammals	2,440	26,905	41,780
Songbirds	1,220	13,453	20,890
Herpetofauna	1,269	13,991	21,726

South Kaiparowits Lease Area			
	Coal Production (MTY)		
	2	30	45
Lost Habitat (acres)	726	4,373	5,623
Category of Wildlife	Number of Animals Lost or Displaced		
Deer	7	4	56
Large Predators	—-	—-	—-
Game Birds	145	875	1,125
Small Mammals	3,630	21,865	28,115
Songbirds	1,815	10,933	14,058
Herpetofauna	1,888	11,370	14,620

Cumulative Coal Production			
	Coal Production (MTY)		
	5	54	84
Lost Habitat (acres)	4,992	19,338	23,563
Category of Wildlife	Number of Animals Lost or Displaced		
Deer	50	193	236
Large Predators	10	39	47
Game Birds	998	3,868	4,713
Small Mammals	24,960	96,690	117,800
Songbirds	12,480	48,345	58,908
Herpetofauna	12,979	50,279	61,264

Source: ERT Project Team
[1]Derived from population information contained in the Draft Environmental Statement - Federal Coal Management Program (U.S.D.I., BLM 1978).

Spills of motor fuel, lubricating oil, or cleaning compounds can introduce toxic substances to aquatic ecosystems, but amounts are seldom large enough to cause impacts except in highly localized areas. Because coals in the area are low in sulfides, acid mine drainage is not expected to be a problem with underground mines. Even if acid drainage develops, the alkaline high-buffered receiving waters would tend to prevent significant impacts. Changes in surface water quality or quantity could have severe impacts to terrestrial wildlife because water is often a limiting resource in semi-arid environments.

Demand would increase for hunting, fishing, and other recreation related to wildlife. Legal harvest would be regulated by state agencies; however, illegal harvest of game and other wildlife violations (e.g., shooting raptors) would increase. There is a correlation between population growth and increased arrests for wildlife violations, especially in energy development areas (Repsis 1977). Increased human populations and access to remote areas would lead to increased wildlife disturbance and harassment. Human recreation and off-road vehicles would displace many wildlife species and thereby increase acreage of lost habitat. Human disturbance during nesting, calving, and fawning periods may significantly impact wildlife by decreasing their productivity.

TABLE 4-21
ARCHAEOLOGICAL RESOURCE IMPACTS FOR EACH SCENARIO

Coal Lease Areas	Low		Medium		High	
	Impact Area (sq. mi.)	Expected Number of sites	Impact Area (sq. mi.)	Expected Number of sites	Impact Area (sq. mi.)	Expected Number of sites
Alton	5.9	104	15.0	264	15.0	264
North Kaiparowits	0.8	5	8.4	57	13.1	87
South Kaiparowits	1.1	7	6.8	44	8.8	57
Subtotal	7.8	116	30.20	365	36.90	408
Truck Haulage	NA	NA	-	-	-	-
Coal Slurry	-	-	-	0-7 per segment	-	0-7 per segment
Railroads	-	-	-	2-18 per segment	-	2-18 per segment
New Community (East Clark Bench)	-	-	6.1	67	6.1	67
TOTAL	7.8	116	36.30	434+	43.00	475+

Source: ERT Project Team

Mitigation Measures. Impacts to wildlife could be mitigated by implementation of the following mitigation measures:

- Reclamation for wildlife habitat - include vegetation species and spatial distribution of communities necessary for food and cover.
- Replace topography pursuant to OSM regulations.
- Enhance habitats adjacent to mine area before and during mining to relieve competition of spatially displaced wildlife.
- Provide drift fences with one-way deer gates, signs, and lower speed limits along road segments exhibiting high deer mortality.
- Increase the number of wildlife law enforcement officers and decrease the size of their area of responsibility on and near the study area.
- Provide more signs and stringent penalties to control ORV use of adjacent lands.
- Avoid construction through riparian habitat, animal concentration areas, near endangered raptor nests, or other areas of important habitat (e.g., Utah prairie dog towns).
- Avoid major disturbance to wildlife during critical periods of the year (usually winter) and critical times of day (early morning, late evening).
- Flag sensitive areas during construction.
- Prohibit possesion of firearms by mine employees on mine property.

Paleontological Resources

Impacts to paleontological resources would consist of losses of plant, invertebrate, and vertebrate fossil materials for scientific research and losses for future public education (interpretative programs). Losses would result from destruction, disturbance, or removal of fossil materials as a result of coal mining activities, unauthorized collection, and vandalism. A beneficial impact of development would be the exposure of fossil materials for scientific examination and collection which otherwise may never occur except as a result of overburden clearance, exposure of rock strata, and mineral excavation.

Impacts resulting from subsurface mining would consist chiefly of localized disturbances from tunneling to reach coal and surface construction of mining facilities. The probability of impact to significant fossils by removal of the coal itself and subsequent land subsidence is low. In surface mining, potentially much greater impact may occur as fossiliferous overburden is removed to reach

coal. Although fossil occurrences tend to be isolated and limited, a very large area would be involved in this type of development and a high potential for impacts to significant fossils exists in formations of moderate, major, and maximum sensitivity (Table 3-7). No paleontological impacts are expected in areas of minimum sensitivity. Indirect impacts would result from increased human access, use of developed lands and surrounding areas, and collection of resources by "rock hounds".

Mitigation Measures. In order to mitigate impacts to paleontological resources the following mitigation measures could be implemented.

- Proposed development in areas of moderate, major, and maximum paleontological sensitivity should be preceded by a detailed field survey. This study should include a careful examination of all exposures of sedimentary bedrock which would be disturbed by development, with a reconnaissance level survey of actual development sites.

- All significant paleontological resources discovered in exposures which would be developed should be collected prior to development.

- Significant paleontological resources outside of actual development sites, but within lease area, should be protected either by collecting the resources or by restricting public access to the sensitive areas.

- Should significant fossils be discovered in circumstances which render salvage impossible, the minimum area necessary to avoid serious impact should be restricted from development.

Archaeological Resources

Specific Assumptions and Analysis. Potential direct impacts to prehistoric archaeological resources from various levels of coal development in the study area were determined. Quantifications were based on anticipated impact areas and intensities for various development scenarios. These are compared against the archaeological site densities and sensitivities presented in Chapter 3. To quantify the estimated impacts, the size of the impact area within each mining area was first calculated. This direct impact area was then apportioned into three fractional parts in proportion to the percentage of areas of projected high, medium, and low site density within the whole corridor segment or particular mining area. Each of these area fractions was then multiplied by a corresponding high, medium, or low site density factor. Modal factors of 18.7, 5.5, and 0.25 sites per square mile were taken from the respective high, medium, and low site density ranges described in Chapter 3. Summation of the products yielded the number of sites which may be expected to be found within the total impact area for a particular corridor segment or mining area at a particular development intensity.

This derivation of the expected site numbers per impact area and development scenario is uncompensated with respect to the factors of (1) the specific distribution of site densities within an overall corridor segment or mining area and (2) site avoidance through project relocation or realignment. The numbers should be interpreted as representing first approximations of levels of potential impact to archaeological sites and are intended to be used as comparative indicators between various development areas and levels. Accurate quantification of actual site numbers in specific areas must result from sample or intensive surveys of the particular areas themselves. The estimated impact levels are given below in outline and tabular form. Total resource sensitivity is obtained by comparing these figures against the information on site type and condition by specific area provided in Chapter 3.

Impacts. As indicated in Chapter 3, the study area contains numerous archaeological resource sites. Development of coal at the low scenario level would be expected to directly affect approximately 116 cultural resource sites (Table 4-21). The significance of impacts to archaeological resources would be dependent upon the value of the sites affected. (See Chapter 3 for description of significant resources.) It does not appear that development of coal under this scenario would adversely affect any sites on or nominated to the National Register of Historic Places.

Mitigation Measures. There are several specific mitigation measures available to protect archaeological resources (see Appendix I). However, before construction of a project could proceed, the applicant would be required to conduct an intensive archaeological resource inventory within the areas to be disturbed. Native American representation on

the survey team would aid in the identification of significant sites. Appropriate site specific measures would be developed if archaeological resources could not be avoided. Mitigation measures could be quite effective (50 to 90 percent) in reducing adverse impacts to archaeological resources.

Native Americans

Specific Assumptions and Analysis. A Native American sacred cultural resources study was completed as part of the Kaiparowits study and the detailed results have been presented in a technical report (Stoffle 1980). The detailed methodology of the study has been abstracted and is included in Appendix E. The study findings did identify some specific Native American concerns about development in the study area and did provide a detailed discussion of sacred resources in the area. The sacred resources were divided into the following concerns: animals, plants, places, and trails. Without a specific proposal it was difficult to determine specific impacts to many of these resources because actual locations were not available. Therefore, general impacts to Native American sacred cultural resources are presented in this report. Stoffle's report is a project support document and can be used by BLM and other appropriate Federal agencies when site-specific proposals are evaluated.

Impacts. One or more of the potentially impacted Native American groups has sacred cultural resources in each transportation corridor, in each coal production area, and in the lands lying just outside these specified areas but still within the overall study area boundary. It is probable that any development requiring excavation would adversely impact these resources.

Examples of potential impacts to these sacred resources that have been expressed by Native Americans include the disturbance of Paiute burials without proper supervision by family members and/or a respected ceremonial leader. This would lead to long-term grief and emotional stress among family members. Concerning sacred plant resources, any reduction in the availability or quality of Native American basket plants, such as willows and Devils Claw, that are essential in making the Navajo Wedding Basket could adversely impact the basketmaking component of the Willow Springs Paiute's economy. This would in turn reduce the availability of this ceremonial basket to the Navajo people. The following points should be emphasized regarding sacred places and trails: (1) trail sections still exist in most section of the study area; (2) some trails are more significant than others; (3) trail preservation is better in dry areas; and (4) Indian people would come forward to speak their concern for specific trails if a project location were specifically defined.

The Native American people's concern about any development in the study area can be summarized with the following statement made by Chairman Benioh (1979) of the Southern Paiute Indians:

> "I, as like many of the Southern Paiute Indians, oppose any project that will bring destruction and unequal balance to sacred territorial lands of Native Americans. God created this earth with all living matter, and he told us to respect all living, including the plants, trees and wildlife. Each animal has a legend behind it, each plant has a spirit within it; we bring upon ourselves injustice if we are not in harmony with respect to each living matter that God has created. I assume that this coal project will bring many distasteful feelings amongst my people for disturbing the peaceful earth. It is not right, in the Indian's eye, for man to disturb that habitat based on Indian belief and religion. There are sacred elements there that have meaning to the Paiute people."

Mitigation Measures. The most significant mitigation measure to reduce impacts to Native American sacred cultural sites would be to insure that future site-specific projects are evaluated in compliance with the following laws and regulations:

- National Environmental Policy Act
- American Indian Religious Freedom Act of 1978
- Historic Preservation Act

Early consultation with affected Native Americans would identify significant Native American concerns and sacred cultural sites within the proposed project area. Evaluation of the potential project's effects on these resources during the environmental assessment or statement process would be accomplished, and specific mitigation measures would be identified to reduce significant adverse impacts.

FIGURE 4-14. Alton Coal Lease Area looking south from Bryce Canyon National Park.

Visual Resources

Impacts. Surface mining at the Alton lease area would exceed the visual class standards of all visual classes assigned for the area. It is expected that Class III and Class IV standards could be met within ten years after reclamation is begun (USDI, BLM, MFP Supplement, 1980). However, it is uncertain whether the standards for the Class II area at the northeast end of the lease area could be attained even after reclamation is completed (USDI, Geological Survey 1980).

The Class II area of the Alton lease area is extremely sensitive because it is at the edge of the foreground-middleground area for Yovimpa Point overlook in Bryce Canyon National Park (Figure 4–14). Figure 4–15 illustrates line-of-sight cross-sections demonstrating that the east end of the lease area would be readily visible from the scenic overlook. Surface mining activity would intrude on the natural character of current views and would be particularly obtrusive as dusk approached and the mining area was artificially lighted.

Mitigation Measures. A number of possible measures could be taken to mitigate visual quality impacts associated with coal development and transportation. A key measure would be to reduce surface mining of coal in the foreground-middleground area of the Alton lease area at the foot of Yovimpa Point. This would reduce impacts associated with the Class II area of the Alton field. Additional mitigation measures are identified in Appendix I.

Recreation Resources

Impacts. Recreation traffic would conflict with production employee commuting hours. (See Transportion Section for more thorough discussion.) Effects of increased use of recreation resources from coal related population growth are illustrated in Table 4–22. Increased recreation demand would result in excessive use pressure on developed facilities, such as campgrounds, which are currently near capacity or over capacity. Back country recreationists would find it harder to avoid other parties, there would be more conflict between incompatible uses such as hiking and motorcycling, and hunters and fishermen would either find greater licensing restrictions or lowered success rates.

Mining activities would degrade visual quality of views from Yovimpa Point which

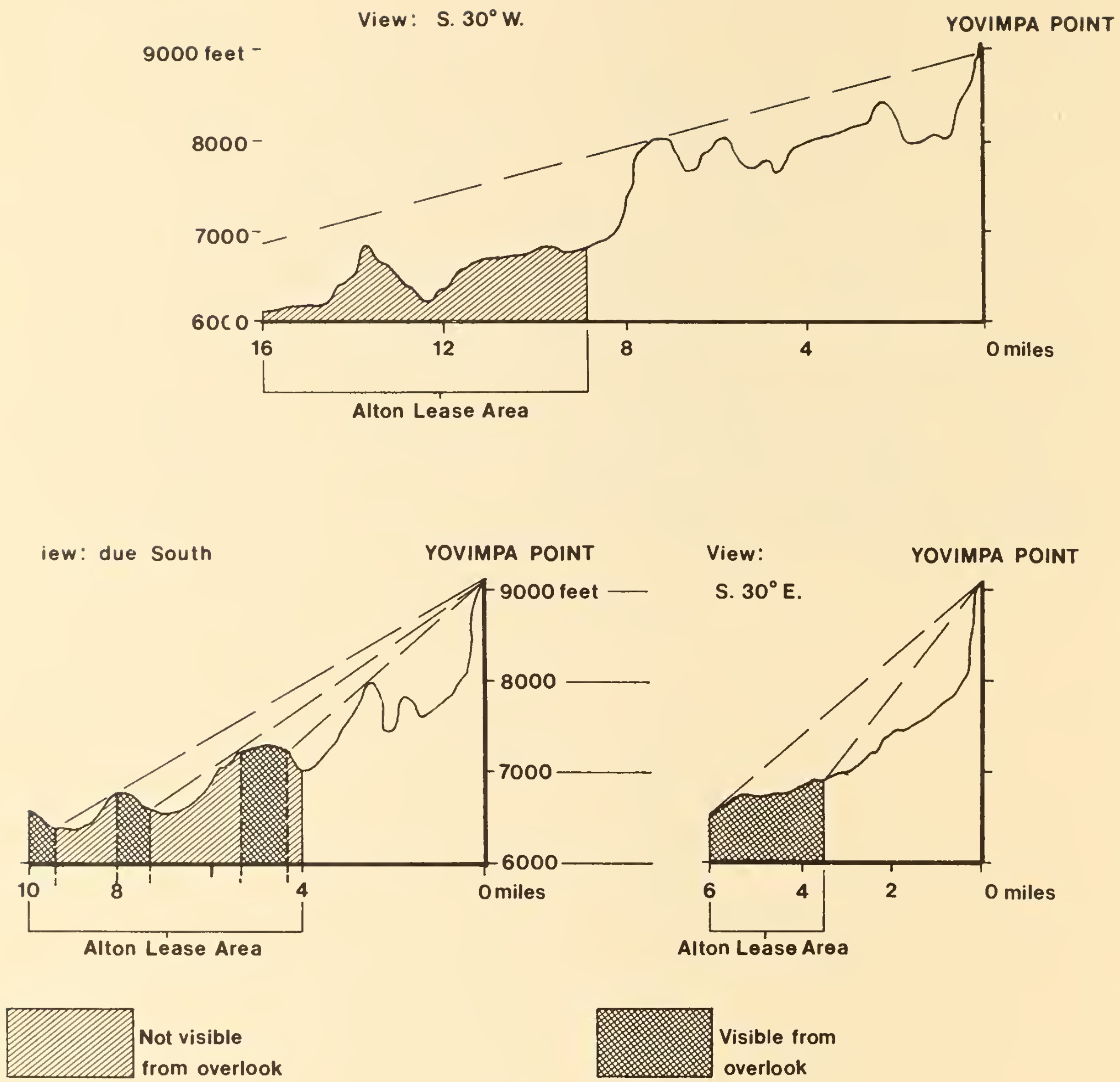


Figure 4-15. Cross-section View of Sight Lines from Yovimpa Point Overlook to Alton Lease Area.

TABLE 4-22

COAL DEVELOPMENT IMPACTS ON RECREATION USER VISITS

			Low Production Scenario			Medium Production Scenario			High Production Scenario		
Year	Total[1]	Local Population Generated	Coal Related	Total	% of Baseline Total	Coal Related	Total	% of Baseline Total	Coal Related	Total	% of Baseline Total
1980	8,500,000	556,201	-	556,201	6.5%	-	556,201	6.5%	-	556,201	6.5%
1985	12,900,000	674,099	50,773	724,872	5.6%	384,456	1,058,555	8.35%	462,176	1,136,275	8.8%
1990	18,263,000	764,409	68,707	833,116	4.5%	464,765	1,229,174	6.7%	690,926	1,455,335	8.0%
1995	25,838,000	838,506	74,188	912,694	3.5%	578,683	1,417,189	5.5%	921,286	1,759,792	6.8%
2000	36,603,000	932,769	85,113	1,017,882	2.8%	537,837	1,470,606	4.0%	859,524	1,792,293	4.9%

Source: ERT Project Team

[1]Assumes a 7.2% per year visitation growth rate projected by NPS. This may be optimistic given increasing gasoline prices.

could lead to a decline in the quality of the recreation experience, perhaps to the extent that tourism would be negatively affected. However, the state of the art of estimating tourism effects of degraded visual quality has not advanced to the point where definitive conclusions can be reached. Studies to date suggest some probable tourism implications of coal development in the study area. Estimates of impact levels vary but studies agree that reduced visual quality would reduce the quality of the recreation experience and thus negatively affect tourism levels (Stoffle and Last 1980, Brookshire et al. 1976).

It is probable judging from the conclusions of the above referenced studies, that coal development at the east end of the Alton lease area would negatively affect the quality of the recreation experience at Yovimpa Point overlook in Bryce Canyon National Park due to the non- natural appearance of surface mining. To the degree that the overlook is an important visitor attraction, a slight reduction in tourism would result (see especially Stoffle and Brookshire though neither specifically addresses mining). The effects would be expected to correlate roughly with the amount of land disturbed.

Wilderness Resources

Impacts. A proposed wilderness study area at the northeast corner of the South Kaiparowits lease area would, if approved, preclude development of surface facilities on about 10 percent of that area. No other significant wilderness effects would be anticipated.

Land Use

Impacts. Land use impacts from coal development would be focused on the coal lease areas and can be added to the transportation effects described earlier. This section concentrates on the coal lease areas and does not repeat material covered previously. As noted in Chapter 3, there is a small portion of cropland in the northwest end of the Alton lease area. The remainder of the area consists of grazing land with some dispersed recreation. However, a sizeable area of 9,000 to 10,000 acres of grazing land, also at the northwest end, contains parcels of prime agricultural land (Map 3-9). Under the low production scenario, a total of 3,778 acres would be disturbed. Mined land would be out of production for the year of mining plus 12 years required for reclamation. Other disturbed lands would be out of production for the life of the project plus 12 years. The loss of cropland in the Alton lease area would be considered a significant impact because of the scarity of cropland in the study area.

Underground coal production for the North Kaiparowits lease area would convert at total of 488 acres of grazing and forest lands to mining purposes. Underground coal development at the South Kaiparowits lease area would convert 726 acres of grazing land for 40 years. Grazing losses could be significant to individual lease holders but would not be a significant impact from a regional standpoint. Forest areas to be disturbed could be harvested prior to mining but replanting would be delayed and future value of immature trees would be lost.

In summary, the production of coal for the low scenario would directly result in conversion of approximately 4,992 acres of cropland, grazing land, and forest land to mining and mining related activities. The loss of cropland would be considered a significant adverse impact. The loss of grazing land would adversely affect individual lease holders, but would not significantly affect regional grazing activities.

TABLE 4-23

PROJECTED HIGHWAY PEAK-HOUR TRAFFIC DEMAND LOW COAL PRODUCTION LEVEL

Highway Location	Projected Baseline Hourly Demand[1] Estimates	Coal Development Generated Auto and Truck Traffic[2]	Total Peak-Hour Demand	Level of Service B Volumes[3]	Peak-Hour Demand Service Volume B Ratio
U-12 West of Escalante	215	185	400	500	0.80
U-12 West of Cannonville	165	75	240	540	0.44
U.S. 89 North of U-12	470	85	555	750	0.74
U.S. 89 South of U-12	470	70	540	720	0.75
U.S. 89 South of Glendale	520	105	625	465	1.34
U.S. 89 North of Kanab	425	70	495	800	0.62
U.S. 89 East of Kanab	550	200	750	735	1.02
U.S. 89 West of Glen Canyon City	305	190	495	735	0.67
U.S. 89 East of Glen Canyon City	305	245	550	735	0.75
U-14 West of U.S. 89	175	80	255	335	0.76

Source: ERT Project Team
[1]Baseline hourly demand for recreation season travel.
[2]Truck volumes represent "worst-case" facility loadings on possible haul route destinations.
[3]Level of Service B volumes from Utah Department of Transportation

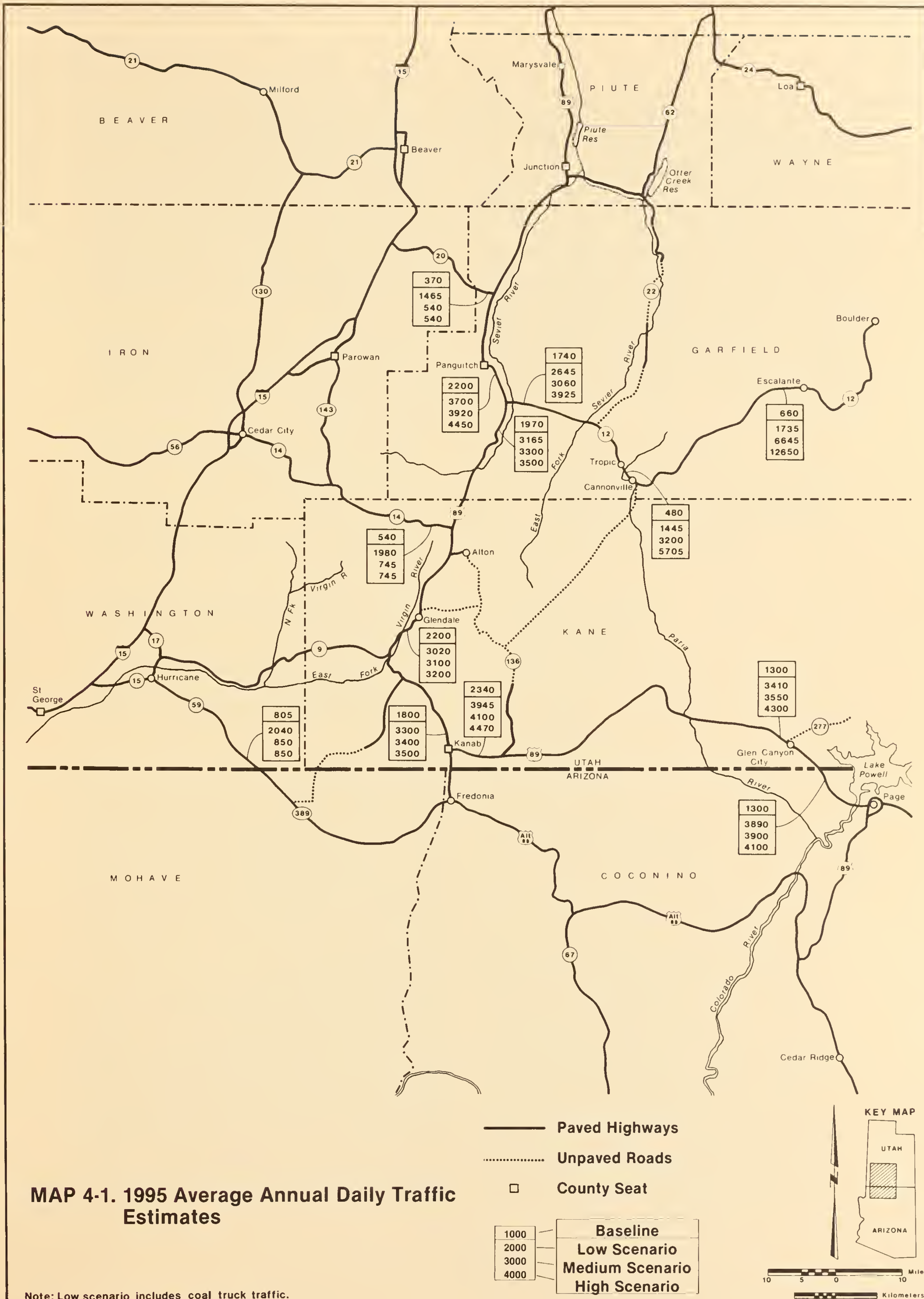
Transportation

Impacts. The combined impact of the mine employee and coal truck traffic would be most concentrated near the intersections formed by the access roads to the coal lease areas and the existing regional highway system (see Map 4-1). For the North Kaiparowits lease area, the maximum concentration of traffic would occur on U-12 just west of Escalante. Traffic from the Alton lease area would use either Route 136a to access U.S. 89 by Alton or Route 136b to U.S. 89 east of Kanab. The South Kaiparowits mine traffic would use a new access road to access U.S. 89.

Table 4-23 summarizes the expected coal development peak-hour traffic impact for select locations on the regional highways serving the lease areas. The peak-hour volumes shown represent the cumulative demand of the traffic flow on the highways during the summer recreational period and the coal development generated traffic. Traffic volumes during the summer months were used to represent baseline conditions because of the higher observed demand due to recreation trip making.

The Utah Department of Transportation (UDOT) has a preferred maximum traffic volume on principal and minor arterials in rural areas, Level of Service B. At Level of Service B, traffic is operating in a stable flow condition with operating speeds just starting to become affected by traffic conditions. Table 4-23 summarizes the relationship of the projected peak-hour traffic demand to this standard. The major area of concern with respect to highway facility capacity is U.S. 89 between U-9 and U-14 (segments 89d and e). Because of the steep vertical grades and sharp horizontal curvature on this segment of U.S. 89, the assigned Level of Service B volume is low (465 vehicles per hour) compared to the other sections of U.S. 89. As a result, the projected peak-hour demand would exceed the Service B standard by 34 percent. On this segment of U.S. 89, a reduction in operating speeds would likely occur with accompanying driver inconvenience due to the nature of truck operations on long vertical upgrades.

Because of the increased vehicle-miles of travel on regional highways due to the coal development traffic, it is likely that the number of accidents would also increase. The observed accident rate on regional highways ranges from 0.88 to 1.75 accidents per million vehicles miles (MVM) on U.S. 89 in southern Utah, 2.71 accidents per MVM on U-12, and 4.05 MVM on U-14 (UDOT 1980, personal communication). Applying the above rates to the vehicle-miles of travel attributable to coal development employee and coal truck travel, it is estimated that approximately 125 to 150



MAP 4-1. 1995 Average Annual Daily Traffic Estimates

Note: Low scenario includes coal truck traffic.

more accidents per year could occur in the study area at the low production level due to the additional coal-related travel.

In addition to the mine employee commuter traffic, localized increases in traffic demand in the population centers could be expected due to trip making by mine worker family members and service industry activity. Assuming that each household would generate an average of four round trips per day for non-work related activity such as shopping, school, personal business, and recreation, the following level of induced traffic could be expected in the communities with the largest forecasted population increases (Table 4-24). This would cause a small increase in urban traffic volumes.

TABLE 4-24

COAL DEVELOPMENT-INDUCED TRAFFIC ESTIMATES - 1995 LOW PRODUCTION LEVEL - NON-WORK RELATED TRIPS

Community	Coal Development Induced Daily Round Trips (Non-Work Travel)
Escalante	745
Tropic	535
Kanab	2,170
Glen Canyon City	820
Page	2,800

Note: Household unit generation rate includes increment for service industry trip making.

Source: ERT Project Team

Mitigation Measures

- The use of U-14 as a truck haul route is questionable because of the long steep vertical curves, the horizontal curve switchbacks on the descent into Cedar City, the frequent closing of the road due to snow during the winter, and the 20,000 pound load limit during the spring months due to the wet subbase conditions. The possibility exists to route loaded coal trucks to Cedar City via segments 136b, 89f, and 389 and I-15. Unloaded coal trucks could return via U-14 when weather conditions permit.

- An alternative to routing coal trucks down Johnson Canyon Road (segment 136b) and through Kanab from the Alton lease area would be to bring trucks directly to U.S. 89 at Glendale, down the partially paved and gravel road segment south of U-9 at Mt. Carmel, and up segment 389 and I-15 to Cedar City. This alternative routing alignment avoids routing traffic through the populated area of Kanab.

- To alleviate the impact of the coal trucks on vehicle operating speeds, climbing lanes could be constructed on the haul routes in areas of long, steep vertical grades.

- Deteriorating roadway pavement conditions could be mitigated by reconstruction or resurfacing.

- Implement STOP sign control at key interaction areas to assign vehicle right of way.

- Maintain centerline pavement markings to separate opposing traffic flow.

- Use advance warning signs to inform drivers of potential conflict or operationally dangerous areas (i.e. sharp horizontal curvature, steep vertical grades).

Socioeconomics

Population projections for the year 2000 with low level coal development are illustrated in Table 4-25. Year 2000 projections are presented here because coal production and related population effects would be stabilized by that time. Projections for other years are presented in Appendix K. Population effects at the low development level are significant but would not be beyond the means of most communities to adjust.

Mining at the low level would provide approximately 990 jobs and coal hauling would provide an additional 1,000 by the year 2000. These increases would significantly alter the employment structure of the study area but would to dominate it. See Chapter 3 for comparison. The estimated direct effects of this employment on the local economy would be $18.9 million per year from mining salaries and an additional $16.1 million per year from coal transportation salaries (both in 1980 dollars). No estimate of secondary employment or income effects was made. The com-

TABLE 4-25

PROJECTED BASELINE AND COAL DEVELOPMENT POPULATIONS FOR THE YEAR 2000

		Coal Development Impacts			Total		
	Baseline	Low	Medium	High	Low	Medium	High
Garfield County	7,616	2,288	17,634	34,754	9,904	25,250	42,370
Antimony	105	46	353	695	151	458	800
Boulder	150	45	353	695	195	503	845
Cannonville	152	252	1,940	3,823	404	2,092	3,975
Escalante	760	732	5,642	11,121	1,492	6,402	11,881
Hatch	150	92	705	1,390	242	855	1,540
Henrieville	310	252	1,940	3,823	562	2,250	4,133
Panguitch	2,990	229	1,763	3,476	3,219	4,753	6,466
Ticaboo	2,000	-	-	-	2,000	2,000	2,000
Tropic	575	525	4,055	7,993	1,100	4,630	8,568
Unincorporated	425	114	883	1,737	539	1,308	2,162
Kane County	8,764	4,257	37,284	53,537	13,021	46,048	62,301
Alton	53	121	129	129	174	182	182
Glendale	315	291	310	315	606	625	625
Kanab	6,660	2,131	3,220	4,100	8,791	9,880	10,760
Mt. Carmel	175	145	155	155	320	330	330
Orderville	543	339	362	362	882	905	905
Glen Canyon City	-	917	1,927	2,832	917	1,927	2,832
New Town	-	-	30,847	45,315	-	30,847	45,315
Unincorporated	1,016	315	336	336	1,331	1,352	1,352
Washington County[1]	37,524	-	-	-	37,523	37,524	37,524
Hurricane	3,001	-	-	-	3,001	3,001	3,001
St. George	19,512	-	-	-	19,512	19,512	19,512
Beaver County[1]	5,871	-	-	-	5,871	5,871	5,871
Beaver City	2,290	-	-	-	2,290	2,290	2,290
Milford	1,996	-	-	-	1,996	1,996	1,996
Minorsville	763	-	-	-	763	763	763
Unincorporated	822	-	-	-	822	822	822
Coconino County, Arizona							
Page	4,878	2,751	3,856	5,664	7,629	8,734	10,542

[1]Coal development impacts limited to transportation construction activities which would be completed prior to 1990.

bination of almost 2000 new jobs at above average wage levels and increased demand for housing, sources and goods due to population increases would tend to "bid-up" prices somewhat which would adversely affect current residents living on fixed or slowly rising incomes.

Impacts of low level coal development on county provided sources would be relatively minor in most cases. Highway maintenance, as discussed in the Socioeconomics Technical Report (Five-County 1980) and the Transportation section would be significantly affected. Both Kane and Garfield Counties would face hospital expansion needs. In addition, Kane County would face capital expansion needs for solid waste disposal sites and for airport improvements.

Fiscal impacts of low level coal development would be positive for both Kane and Garfield Counties. Operating and maintenance expenditures per capita would decline somewhat for reasons discussed in Chapter 3 and in the Socioeconomics Technical Report (Five-County 1980). Meanwhile, county revenues would increase as a result of the expanded property tax base created by coal development thus providing a surplus of revenues over operating expenditures.

There would be adverse fiscal impacts on all communities under the low level coal development scenario. Assuming tax rates and fees would remain constant, all communities impacted by coal related population increases would face increasing per capita costs and decreasing per capita revenues as discussed in Chapter 3 and in the Socioeconomics Technical Report (Five-County 1980). These revenue shortfalls would be quite large, requiring doubling of revenues in some cases to maintain service levels.

In addition, many communities would face substantial capital expansion needs for schools, municipal offices, libraries, parks, police and fire protection equipment and facilities, wastewater treatment systems and domestic water treatment systems. These needs would range from a few thousand dollars for fire hydrants to over $10 million for new schools. Capital improvement needs impacts would be especially severe for facilities such as wastewater treatment systems, domestic water systems and schools which must be in place before population growth occurs and thus, before any new revenues would be available.

No housing analysis was conducted for this study.

Mitigation Measures

- If a revenue sharing program between counties and communities could be instituted the county revenue surplus would be almost sufficient to offset the community revenue shortfalls.

- The State of Utah has enacted legislation providing alternative financing methods to reduce the "front-end" capital financing problems.

- Detailed planning and management preparation for rapid growth would serve to reduce the adverse impacts of coal development on communities.

Socio-Cultural

Impacts. Rapid population growth in small communities invariably creates certain types of problems which the communities must confront. However, the major socio- cultural impacts are not just a function of increased size. In addition, the processes of demographic, ethnic, and cultural diversification can contribute to serious adjustment difficulties and can impact the local quality of life. Because most of the communities which would be impacted by coal development in the Kaiparowits region or by alternative transportation methods to remove the coal from Kaiparowits have highly homogeneous populations in terms of cultural traditions and values, ethnicity, and religious identity, the potential impacts are far greater than in larger, more heterogeneous communities. However, it is important to recognize that the impacts are likely to vary significantly from one community to another. The major variables that would determine the extent of impact in any individual community include the following: (1) initial size of the community; (2) current demographic characteristics of the local population; (3) attitudes of community residents toward growth and toward the potential influx of newcomers into their community; (4) the geographic isolation of the community; (5) the relative degree of development of the local infrastructure and service delivery sector; (6) the rapidity of population growth that occurs; (7) the amount of population growth; (8) the characteristics of the immigrants; and (9) the permanence of the growth.

Taking these factors together, it can be predicted that the most significant impacts would occur in communities that are small, that have relatively few local residents who would be able to obtain employment or otherwise benefit economically from the new developments, that are generally opposed to growth or change, that are far enough away from other communities of any size that the work force would be required to live locally, that have relatively undeveloped infrastructure and service delivery sectors (such as no doctors or medical facilities, inadequate education facilities, or little available housing), that would experience significant, rapid growth, and that experience growth largely from the immigration of groups of people that differ significantly from current local residents. The opposite set of characteristics, then, would imply relatively little impact. This indicates that the least significant sociocultural impacts would likely occur in communities like Cedar City, St. George, and Page, Arizona. The most significant impacts would occur in the small, rural communities of Kane and Garfield Counties. Positive impacts would occur in all of these communities to the extent that former residents and children of current residents would be able to return home because of the availability of new employment opportunities.

Coal production of 5 MTY would result in population growth in Garfield and Kane Counties that would range from 208 percent in Panguitch to 383 percent in Glen Canyon City. While this is a significant rate of growth, most of the local communities feel that they could adjust and can respond to the needs of the incoming population. It is anticipated that much of the growth associated with this level of coal production would result from the return migration of former residents. This would be viewed very positively. Service delivery impacts would be experienced and some

changes in local lifestyles would occur but none of these change would be overwhelming to the social structure of the communities.

Noise

Impacts. The major sources of noise from coal development would be located at the mine sites and would result from construction and mining activities. These sources would be in addition to the transportation sources discussed earlier. All the major noise sources for coal development are summarized in Table 4-14. Noise levels for typical construction and mining equipment, based on measurements taken at 50 feet, range between 75 and 95 dBA for loaders, tractors, scrapers, and rock drills. Blasting would be necessary during the construction phases of each mine development and on a continuing basis at the Alton surface mine. A detailed analysis of blasting noise is very terrain- and technique-dependent and is beyond the scope of this analysis.

Mine-related sounds emanating from the coal lease areas are not expected to exceed those found in normal construction activity. Within the mine areas themselves, noise levels are subject to occupational health controls and would be within these limits. The distance between the mine areas and the nearest sensitive receptor would prevent high level sounds from the mines reaching the receptors. This is best illustrated at the Alton lease area, where the northeast end of the lease area is separated from Bryce Canyon's southern extremity by about 3 miles. Table 4-14 indicates that the 90 dBA mine noise level would be attenuated to under 55 dBA at 1 mile distance, and to perhaps 45 dBA under worst-case conditions at 3 miles distance. In afternoon conditions when the winds are light, the 3 mile levels are expected to be below 30 dBA.

Sensitive receptors along the truck haul routes include the pronghorn fawning area northwest of Glen Canyon City and the schools and hospitals in the communities along the highways. Because the trucks are projected to work a five-day week, church activities are not expected to be impacted. Also, because the truck haul is projected to occur between 6:00 a.m. and 10:00 p.m., much of the activity would occur when atmospheric attenuation is maximized.

The greatest traffic flow is projected to occur near Kanab, where trucks from the South Kaiparowits lease area would merge with those coming down Johnson Canyon from Alton before parting in Kanab to continue toward Cedar City and Warner Valley, respectively. The 4 million tons per year carried by that road implies a truck passing each 50 seconds during each 16-hour day. Peak noise values from a 90 dBA truck source are expected to be below 65 dBA (a typical daytime, urban value) at 1,000 feet from the road, and below 55 dBA (a daytime hospital zone value) at 1 mile away. However, this level would be above typical maximum permissible nighttime noise levels of 45 dBA for hospital zones. Assuming that the trucks moved at 40 mph, and their noise-time histories exceeded 65 dBA at 50 feet for 20 seconds for each truck passage, noise levels at roadside exceeding 65 dBA would occur for slightly over 6 hours per day. This level is categorized as normally acceptable by the Department of Housing and Urban Development.

Mitigation Measures

- Where possible within the constraints of the existing highway system, haul trucks should be routed to minimize impacts at sensitive receptors.

Medium Scenario: Coal Production of 54 MTY, Slurry Pipelines and Railroad

For some environmental elements, the overall impacts associated with the medium production scenario would be basically the same as the impacts discussed for the low production scenario with the exception that the land surface areas affected would be much greater and the mode of transportation would be different. Therefore, the mitigation measures and assumptions for the medium production scenario are similar to the measures described for the low production scenario. Unless additional mitigation measures and assumptions are presented with this scenario, the reader should refer back to the specific mitigation measures and assumptions presented for each environmental element under the low production scenario.

Impacts to paleontological resources and Native American sacred cultural resources under this scenario would not be significantly different than impacts described for the low production scenario. Therefore, these elements are not addressed under this scenario.

Air Quality

Impacts. On the local scale, projected unmitigated mine, transport, and urban emissions associated with this scenario are not anticipated to result in the violation of any air quality standards for any pollutant except TSP. Locally, unmitigated TSP mine emissions at all three lease areas would exceed both PSD increments and NAAQS. In addition Class I TSP standards would be exceeded by a factor of as much as 20 and NAAQS by 2 to 3 times (Table 4-15). Unmitigated coal blow-off emissions along the rail line would exceed PSD Class II annual TSP increments at levels above 10 MTY hauled in a single corridor.

The worst-case year for potential regional air quality degradation would occur during the construction period when pipelines and railroads were being built and mine sites and plant areas were being prepared. After that 6-year period, regional concentrations would decrease by about 30 percent as haul road emissions replaced construction dust and slurry pipelines began to transport almost half of the coal associated with this scenario.

On the regional scale, unmitigated emissions would cause ambient 24-hour TSP concentrations exceeding 100 $\mu g/m^3$ in the Bryce Canyon area and in a band running between Escalante and Lake Powell (Figure 4-16). Ambient 24-hour concentrations of about 10 $\mu g/m^3$ would stretch up to 20 miles downwind of corridor construction activities. Beyond about 30 miles downwind of the major sources, background RSP levels would be similar to the contribution made by the baseline (no coal) levels projected for the year 2000. During the operating phase, the combined effects of increased population and unmitigated mining would increase background RSP levels to roughly four times their present value.

The only city exhibiting an identifiable increase above the present TSP values of the existing air quality is the proposed New Town in eastern Kane County. This development would be responsible for RSP increases of 24 $\mu g/m^3$ at a location 10 miles downwind of the city. Projected concentrations of other urban pollutants are low and do not exceed existing applicable air quality standards.

Mitigation Measures. Implementation of mitigation measures would reduce the air quality impacts and alleviate potential air quality standard violations. Appendix J presents a comprehensive list of list of mitigation measures which could be incorporated.

Emission reduction by 88 percent using the mitigation techniques outlined above for the low coal development scenario would be adequate to alleviate local impacts at the North Kaiparowits lease area (see Table 4-15). However, in order to meet PSD increments additional mitigation measures producing an overall emission reduction of 91 and 94 percent respectively would be required for South Kaiparowits and Alton operations (see Table 4-15). Some of the specific mitigation measures which would be effective in mitigating local TSP emissions for each lease area are presented as follows.

To effectively reduce the unmitigated TSP values by 91 percent and to meet the 24-hour Class II PSD increment at the boundary of the South Kaiparowits lease area, the following mitigation measures would be required:

- Use 150-ton or larger capacity haul trucks.
- Use BACT on the mine process sources.
- Pave the portal to plant haul roads.

Alton operations must effectively reduce the unmitigated TSP values by 94 percent to meet the PSD Class I annual, PSD Class I 24-hour, and the Class II 24-hour increments at the Alton lease area. For a surface mining operation, additional mitigation above the 88 percent discussed previously must come from

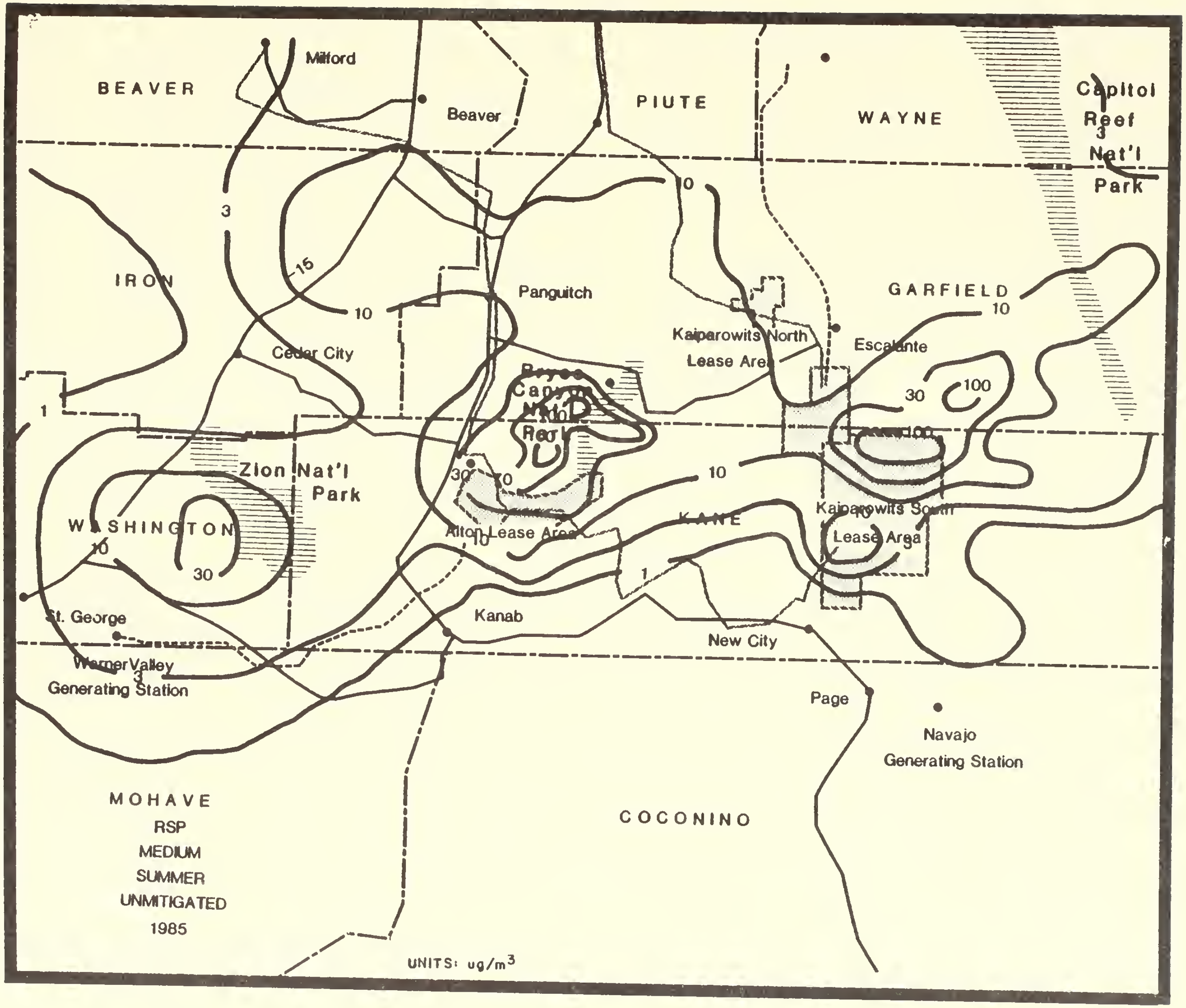


Figure 4-16. Medium Production RSP Concentrations Isopleths (Unmitigated).

methods which may be costly or difficult to implement. Such methods include:

- reduction of haul road length either through the construction of additional processing plants or through a limitation on mine extent (which could be impractical for the desired coal production rate);
- paving haul roads outside of the working pit, i.e. those going to the processing plant; or
- conversion to a conveyor system to move coal from the pit to the processing plant.

Train-related coal blow-off emissions could be effectively mitigated as in the low scenario by spraying the loaded coal with an emulsive bonding agent after it has been loaded on the rail cars. This mitigation measure would be 90 percent effective on blow-off emissions (about 70 percent on overall transport emissions) and would effectively mitigate all potential TSP impacts attributable to rail transportation under this scenario.

On the regional scale, implementation of the mitigation measures previously identified for the low scenario would be effective in reducing the unmitigated mine source terms by about 88 percent and eliminating potential standards violations at all lease areas. Mitigated regional emissions for the medium scenario are summarized in Table J-9 in Appendix J. The mitigation measures would decrease regional RSP levels within 20 miles of the lease areas by a factor of 10 and distant down wind concentrations by a factor of 3 (Figure 4-17). Because the con struction emissions are more difficult to mitigate and soil dust is almost one-third very fine particles, it is expected that some visibility degradation could result even though air quality standards are preserved through mitigation near the coal lease area (see Visibility section).

Visibility

Impacts. In the medium production (54 MTY) scenario, unmitigated coal production would reduce the mean geometric visual range substantially. During the construction phase, the visual range from Bryce Point to Navajo Mountain would decrease from 200 to 109 kilometers (124 to 68 miles) due primarily to railroad and mine site preparation at the Alton and South Kaiparowits lease areas. However, with mitigation measures presented under Air Quality (88 percent effective), the projected visual range would be 177 kilometers (110 miles), an overall reduction in visual range of approximately 12 percent. Navajo Mountain would not be visible in the unmitigated case; however, when mitigated it would be visible about half the time, compared to 75 to 85 percent of the time at present.

During the first half of the operating phase, visibility to Navajo Mountain would be decreased to under 90 kilometers (56 miles) if Alton emissions were unmitigated. The mitigated operating phase would closely resemble the mitigated construction phase, with projected visual range near 177 kilometers (110 miles) and Navajo Mountain visible half the time. The vistas from Lava Point and Hopi Tower would be unchanged from the low scenario values in the medium scenario.

The Langdon Peak and Cottonwood Peak vistas running northward from Bryce Point are estimated to be decreased by about 20 percent in visual range between the low unmitigated and medium scenarios. The Table Cliffs vista would remain within the projected visual range. Mitigation would return the visual range along those vistas to their low scenario values, which are not projected to be significantly impaired.

Refer to the low scenario discussion for a photographic comparison illustrating visibility changes.

Topography, Geology, and Minerals

Impacts. The impacts of coal production in this scenario are similar in nature to those described for the low production level scenario except that the greater volume of coal produced would result in proportionately greater impacts. The volume of nonrecoverable coal would be about 43 MTY in the underground mines and about 0.7 MTY in the surface mines for the first 20 years of production to about 52 MTY and 0.13 MTY for the last 16 years. The volume of limestone needed for rock-dusting in the underground mines would range from about 0.25 MTY for the first 20 years of production to about 0.29 MTY for the last 16 years. Impacts relative to quarrying and hauling cannot be quantified until sources are located. Impacts of slurry pipelines and railroads were discussed under impacts of coal transportation.

Soils

Impacts. Soil impacts are similar to those described under the low production level scenario except that the acreage disturbed would increase to approximately 19,338 acres on the coal lease areas, 3,339 acres as a result of expansion of existing communities, and 3,856 acres for New Town, a community that would be developed on East Clark Bench.

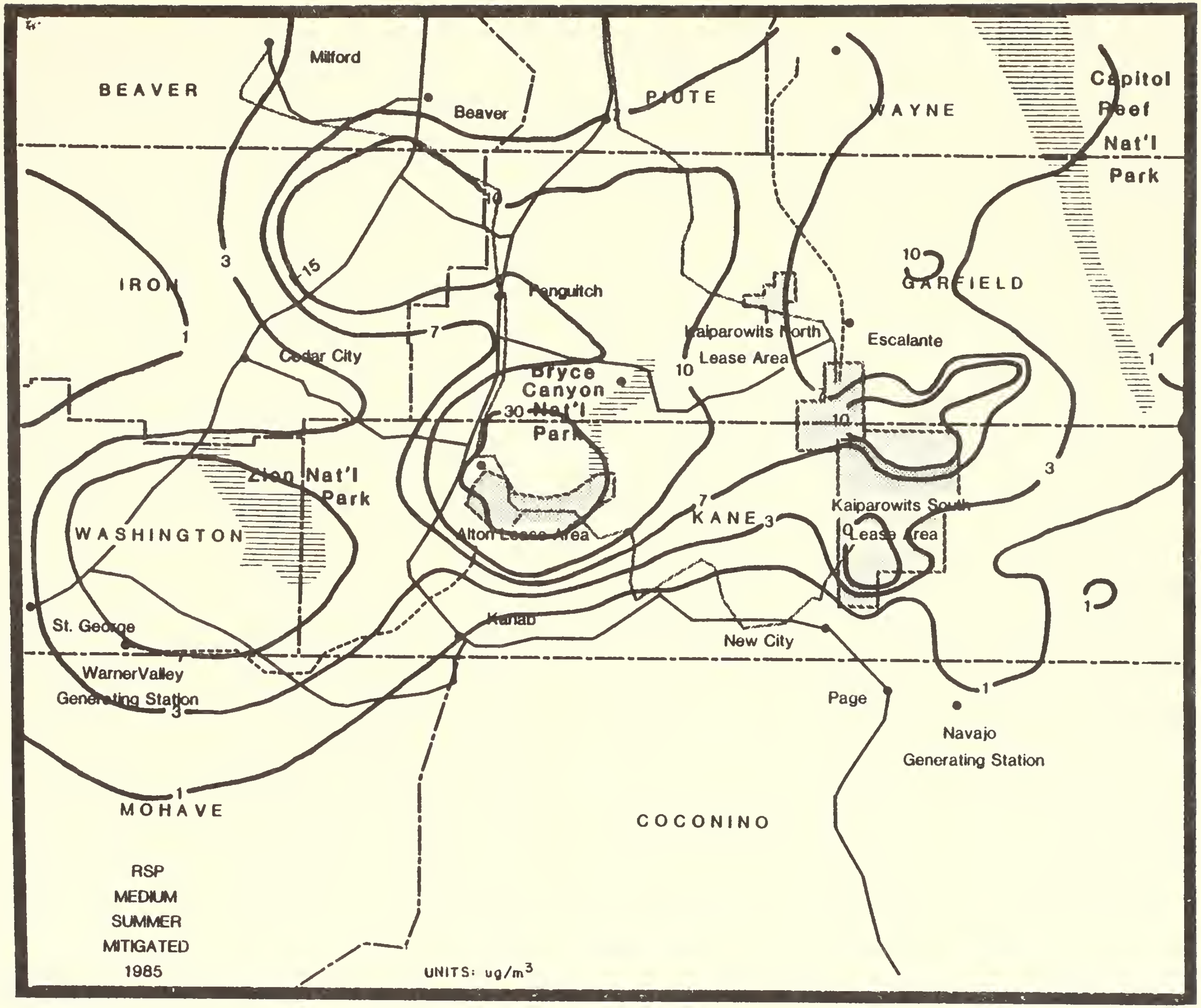


Figure 4-17. Medium Production RSP Concentration Isopleths (Mitigated).

Water Resources

Specific Assumptions and Analysis. The major aquifer underlying the study area is the Navajo Sandstone. Few pumping tests have been made in the lease areas so detailed groundwater computer analyses were made by Hydro-Data in which different factors of pumping rate, transmissivity, storage coefficient, well spacing, and well geometry were considered. Transmissivity values of 6,500 and 10,000 gallons per day per foot (gpd/ft) and storage coefficients from 0.012 to 0.120 were evaluated. After evaluation of these factors, the following input data were selected for analysis.

1. A transmissivity of 10,000 gpd/ft would be a probable figure for both the Alton and North Kaiparowits areas. This value was chosen on the basis of pumping tests that were made outside of the region, both south and north.

2. A storage coefficient of 0.012 increasing in ten years to 0.120 was used because in the cases of interest, i.e. where development was feasible, the aquifer would be under water table conditions during most of the forty years of pumping.

3. The wells were spaced at least 2,000 feet apart because that was about the minimum distance that could be used to maintain the drawdown within limits of possible development.

4. Several well field geometrics were tried. A well field of eleven wells was located to fit the topography in the Alton area. Two well fields were modeled in the North Kaiparowits area. The topography in these well fields permitted uniform well spacing of twenty wells in each field.

Extensive surface water analyses were conducted on several streams in the study area. A combination of the U.S. Corps of Engineers HEC-1 computer program and the Soil Conservation Service TR 20-A program was used to analyze runoff peaks for various streams. In addition the 50 and 100-year floodplain widths were calculated for the following streams:

Otter Creek	East Fork Sevier River
Sevier River	Wahweap Creek
Kanab Creek	Johnsons Wash
Sandredge Wash	Paria River
White Sage Wash	Pipe Valley Wash

It was generally concluded that the mining operations and transportation modes would not adversely affect surface water resources. However, the flood plain formation should be used by BLM and future applicants in planning and right-of-way selection for site specific proposals. This information would be helpful in designing structures that would be adequate to cross the flood plains. The detailed surface water analysis and flood plain maps have been provided to BLM as project support materials.

Impacts. The general impacts described for the low production level would be expected to increase in proportion to the increased level of activity and area disturbance at the coal lease areas. In addition, the medium level coal development scenario would exercise the greatest demand on the water supply primarily as a result of coal slurry pipeline operation. The water supply in the Alton lease area would come from groundwater stored in the Navajo Sandstone. Based on the limited available information on aquifer characteristics and computer modeling performed by Hydro-Data, water level drawdown in the immediate vicinity of the well field would reach 250 feet after 20 years of pumping and increase to 350 feet after 40 years. The area of regional drawdown effect was designated as the area around the well field in which the water level within the Navajo Sandstone aquifer would be lowered more than 1 foot. A 1-foot drawdown would occur around the Alton well field extending to a radius of 11.8 miles after 40 years of pumping in the pattern depicted on Map 3-3 and Figure 4-18. The cone of depression would be expected to invade the East Fork of the Virgin River. Water losses from the river's bank storage to the Navajo Sandstone aquifer are estimated by computer modeling to range from about 1 cubic foot per second (cfs) after 20 years of pumping, gradually increasing to about 2.5 cfs after 40 years, and continuing to increase slightly for several years after pumping ceases. These figures represent the average loss of water to the aquifer. The rate of loss would be slightly higher during periods of high river flow and slightly lower during periods of low river flow. This would constitute a flow reduction of about 25 percent of the mean flow to perhaps 50 percent of the low flow of the East Fork of the Virgin River in the Alton area. Affects would decrease downstream as more water would enter the river from bank storage.

LEGEND

* WELL FIELD

CONTOURS: 1, 20, 40, 60, 80, 100 Feet

SCALE: 1:565,000

NORTH

Figure 4-18. Cone of Depression at the Alton Lease Area After 40 Years of Pumping.

Different values of transmissivity and storage coefficient that were analyzed yielded higher estimates of water loss from the river. Values presented in this report are those that Hydro-Data believes most reasonable. Site-specific evaluations of water resource impacts would be necessary for any proposed coal development as water requirements, well field location, and data from test wells within a proposed well field may alter computer modeling results. The potential impact to aquatic wildlife as a result of the drawdown is discussed in the Wildlife section. Spring flow to Kanab Creek near the White Cliffs area and spring flow in Johnson Canyon originating from the Navajo Sandstone would be reduced and interrupted, perhaps entirely.

Water supply in the North Kaiparowits lease area must also come from the Navajo Sandstone. Based on the limited information available, water level drawdown in the immediate vicinity of the well fields would reach 250 feet after 20 years of pumping and increase to 450 feet after 40 years. The 1-foot cone of depression contour would extend an estimated radius of 12.7 miles after 40 years of pumping from either well field analyzed (Map 3-3). The effect on any existing or future wells in the Escalante area would be to lower the water table in the Navajo Sandstone increasing the pumping head about 10 to 20 percent.

The Navajo Sandstone is a confined aquifer with little direct communication with shallower aquifers above. Pumping of the Navajo Sandstone should have insignificant effect on the shallower aquifers and should not affect existing wells. It is these shallower aquifers which provide flow to the springs found in the North Kaiparowits area. Water quality in all the regional groundwater aquifers should not be impacted. Recharge rates to the Navajo Sandstone aquifer are not known at this time but are thought to be quite slow. Hence, utilization of water from the Navajo would essentially amount to mining water. After 40 years, when pumping would cease, the cone of depression would continue to spread in the North Kaiparowits area as water within the aquifer seeks equilibrium. It would probably take many hundreds of years for water in the aquifer to recharge to present volumes and levels. At Alton, recharge from the East Fork of the Virgin River would speed up the process.

Water supply in the South Kaiparowits area would be met with water from Lake Powell. An August 1979 State of Utah, Division of Water Rights memorandum stated: "Lake Powell is perhaps the most favorable source of water for this area. If water was supplied from Lake Powell there would not be a problem with availability and also there would not be direct interference with other existing water rights." However, there is some potential disagreement as to the legal and political problems that may be encountered over the use of Lake Powell water. Calculations performed by the Bureau of Reclamation for the Kaiparowits Powerplant Study (USDI, BLM 1976) indicated that the withdrawal of 50,000 acre-feet per year from Lake Powell for that project would result in an increase in the salinity of the Colorado River at Imperial Dam by an estimated 2.1 milligrams per liter (mg/l). Assuming a linear relation ship between water withdrawn from Lake Powell and salinity increases downstream, water required from Lake Powell for this scenario would increase salinity at Imperial Dam by 0.26 mg/l. This change would be negligible as salinity at Imperial Dam normally ranges between 800 and 1050 mg/l. Future water demands of increased populations resulting from mining operations are projected in Table 4-26. The domestic water requirements would come from Lake Powell or shallower aquifers than the Navajo Sandstone and would not significantly affect the regional groundwater resources.

Mitigation Measures.

- Add water to the East Fork of the Virgin River near Alton to compensate for water loss due to groundwater pumping. Insure minimum flow.
- Locate railroads and pipelines out of stream bottoms, if possible, to minimize sediment entering stream channels.
- Following corridor construction, all disturbed areas, such as storage areas for materials and short access roads, should be cleaned up, rehabilitated, and vegetated to minimize sediment entering stream channels.

Vegetation

Impacts. It is estimated that approximately 19,338 acres would be removed from vegetative production over the life of the coal production areas (Table 4-19). An estimated 709 AUMs per year would be lost from mining areas. Assuming that 13 years would be required before livestock can be allowed back on reclaimed areas, a total of 9,217 AUMs

TABLE 4-26

PROJECTED NEEDS FOR DOMESTIC WATER SUPPLY

Area	Baseline Population	Baseline + Mining Operations	Maximum Growth Year	Acre-feet[1] per Year
Antimony	115	1,594	1987	373
Boulder	140	945	1995	202
Cannonville	142	4,572	1995	1,119
Escalante	755	13,462	1995	3,209
Hatch	150	1,760	1995	406
Henrieville	280	4,710	1995	1,119
Hite	2		1995	0
Panguitch	2,698	6,725	1995	1,017
Ticaboo	2,000	2,000	1995	505
Tropic	575	9,798	1995	2,330
Alton	55	205	1987	37
Glendale	237	593	1987	89
Kanab	4,552	9,443	1987	1,235
Mt. Carmel	122	302	1987	45
Orderville	487	888	1995	100
West Kane County		1,233	1995	310
Glen Canyon City		2,890	1995	729
New Town East Kane County		46,235	1995	11,680

Source: Hydro-Data Inc.
[1]Acre-foot/year = 893 gallons/day

would be lost at this level of production. The estimated 709 AUMs per year lost represents about 1 percent of the available Federal AUMs in the Escalante, Paria, and Zion Planning Units (USDI, BLM 1980b). Expansion of existing communities would consume an additional 3,339 acres of land over baseline conditions (Table 4-27). AUMs lost as a result of this expansion are unquantifiable. The development of New Town would consume 3,856 acres of desert shrub plant commmunity and result in an additional 96 AUMs lost per year; this loss is expected to be permanent.

The possibility that mining would disturb populations of candidate threatened or endangered plant species is evaluated as moderate to low. This is based on the comparison between 19,338 acres disturbed and the approximately 310,000 acres available within the three lease areas, less than 10 percent. This small ratio of disturbance to available area reduces the probability that rare plant habitats would be encountered and increases the option available for avoiding plant populations when found.

Other impacts that could potentially occur at this production level include the disruption of aquifers that contribute water to riparian communities downstream from the coal mining areas (see Water Resources). The composition of these riparian communities would change toward more drought-tolerant species if ground and surface water sources were diverted.

Wildlife

Impacts. Wildlife impacts are similar to those described under the low production level scenario. The severity of impacts would increase in proportion to the area disturbed, increased access to industurbed areas, and the number of people which would relocate into the region (see Table 4-20, 4-27 and Socioeconomic Section). Under this scenario, mule deer reported lost to vehicle collisions would increase 97 percent (165 deer per year) over current conditions. This figure reflects the change in coal transportation methods from truck to slurry or rail.

Aquatic impacts would also be similar to those described under the low production level scenario except that water demand at Alton for operation of slurry lines would result in a reduction of the flow in the East Fork of the Virgin River in the vicinity of Alton (see Water Resources Section). Flow reduction could range from 25 to 50 percent of the existing mean and low flows. These values are estimated to occur at the end of 40 years with

lower but increasing values at earlier periods. After the 40-year mining period, these loss values would increase for sometime before beginning to decrease.

These flow reductions would result in moderate to severe impacts to all aquatic species near Alton. Since these losses would be mitigated downsteam by releases from bank storage, aquatic impacts would be less downstream of the Alton area, but some flow reduction would likely occur throughout the East Fork of the Virgin River below the Alton area. Impacts to Federally listed endangered fish would likely be small, but substantial impacts could occur to state listed species (i.e. Virgin River spinedace) upstream of Mt. Carmel Junction.

Mitigation Measures

- See Water Resources Mitigation
- Monitor populations of state-listed threatened or endangered species

Archaeological Resources

Impacts. Development of coal at the medium production level would be expected to directly affect 365 cultural sites (Table 4-21). In addition, construction of either the coal slurry pipeline or railroads would also directly impact from 2 to 25 additional sites (would be dependent upon the specific corridor segment). Indirect impacts to cultural resources would also result due to construction of limestone quarries for ballast requirements and due to construction of the new community at East Clark Bench. These indirect impacts would also impact an additional 67 sites.

The impact of this scenario on archaeological sites on or nominated to the National Register of Historic Places is unknown because there is no site specific proposal to evaluate. Construction of a coal slurry pipeline or railroad could potentially impact the sites (Table 3-9) which occur in the corridor. However, it would appear that these sites should be considered as a "constraint" and avoided when applicants develop site-specific proposals. This would reduce the possibility of impacting these sites significantly. From a cumulative standpoint, coal development and transportation impacts for the medium scenario would either directly or indirectly impact from 434 to 457 archaeological sites. The overall significance of this impact would be dependent upon the value of the sites affected.

Visual Resources

Impacts. In addition to impacts in the Alton lease area discussed under the low production scenario, surface mining in the northerly section of the North Kaiparowits lease area would not meet the standards of the PR-Partial Retention management objective either during operation or within one year after completion of mining. It would take many years to reclaim the pine forest to the extent that the mining area would not be "visually evident." However, the area is not nearly as sensitive as the eastern portion of the Alton field because it would not be readily visible from a high volume public use area.

Underground mining areas in the southern section of the North Kaiparowits lease area and in the South Kaiparowits lease area would probably meet the visual Class IV standards with some care in locating surface facilities and coal storage piles. Neither area would be highly visible from high use areas and neither area has high scenic quality generally. Class IV standards would certainly be achievable upon cessa tion of mining and completion of successful reclamation. The access road to South Kaiparowits would probably not meet visual Class II standards in the rough terrain at the southern end of the coal lease area. However, it would be possible to avoid the Class II area.

Mitigation Measures. Transportation impacts on visual resources would be reduced by the following mitigation measures:

- Careful siting of rights-of-way to conform with the natural landforms, i.e. wind through the terrain rather than cutting straight lines across the terrain.
- Line and form contrast would be further reduced by careful clearing of rights-of-way and attempting to minimize clearing of natural vegetation whenever possible.

  See Appendix I for additional visual resources mitigation measures.

Recreation Resources

Impacts. Recreation traffic conflicts with coal production employee traffic would be much more severe than for the low production level (see Transportation section). Impacts of increased use of recreation resources from coal-related population growth are illustrated in Table 4-22. Adverse impacts as described under the low production scenario would be

TABLE 4-27

COMMUNITY LAND USE IMPACTS
(in acres)

Community	Existing Development		New Development Demand - Year 2000			
	Total Land Area	Vacant	Baseline[1]	Low	Medium	High
Alton	228	175	7	15	16	16
Antimony	N.A.	N.A.	13	6	44	87
Boulder	N.A.	N.A.	19	6	44	87
Cannonville	80	30	19	32	243	478
Escalante	564	296	95	92	705	1390
Glendale	167	111	39	36	39	39
Hatch	N.A.	N.A.	19	12	88	174
Henrieville	119	54	39	32	243	478
Kanab	670	302	833	266	403	513
Mt. Carmel	N.A.	200	22	18	19	19
Orderville	285	179	68	42	45	45
Panguitch	624	312	374	29	220	435
Tropic	360	188	72	66	507	999
New Town	-	-	-	-	3856	3856
Glen Canyon City	N.A.	N.A.	N.A.	115	241	354
Fredonia, AZ	N.A.	N.A.	-	-	-	-
Page, AZ	N.A.	N.A.	N.A.	344	482	708
TOTAL	3097	1847	1619	1111	7195	9678

Source: ERT existing data from Five-Co. AOG, Planning for Growth in Garfield County (1978), and Planning for Growth in Kane County (1976)

N.A. - Data not available

[1]Baseline land demand is non-coal related and must be added to a low, medium, or high figure to determine total new development land required under one of the three coal development scenarios.

greatly intensified by coal-related population growth (population as much as 8 times larger than the low level).

Visual quality degradation at the Alton lease area would be somewhat greater than at the low level due to increased land disturbance and would therefore be expected to have a slightly greater negative impact on tourism. Visual range in the study area would be decreased by a small but measureable amount (see Visibility Section). The effects of decreased visual range on tourism are unquantifiable, although leading studies have begun to address the question (Johnson 1976; Brookshire et al. 1976). The visual reduction associated with coal development at the medium level (with mitigation measures) would be unlikely to significantly impact tourism. Probable declines in tourism due to degradation of visibility would be offset by increases in tourism from the greatly increased local population.

Wilderness Resources

Impacts. Wilderness effects associated with the medium production level are discussed in detail under the transportation section. At this level there would be greater pressure to permit development of coal in the proposed wilderness study area in the South Kaiparowits coal field. Wilderness study areas, when finalized in November 1980, would preclude development of new rights-of-way for slurry pipelines and railroads within their boundaries until and unless they are dropped from wilderness consideration. (See Map 3-9 for transportation corridors which would be affected.) Of particular concern are the areas south of U-12 in segment C13, the west side of Cottonwood Canyon in segment C15 (Figure 4-5), the Paria Box in segment C14 (Figure 4-9), the western end of segment C10, and the center of segment C7 along Kanab Creek. Designation of the Paria Box as a wilderness study area would severely restrict the develop ment of a rail line to Milford or Cedar City. Engineering and economic constraints of a different crossing of the Corkscomb could be prohibitive.

Land Use

Impacts. Surface and underground coal development in all lease areas would result in conversion of approximately 19,338 acres of crop land, grassland, and forest land to mining and mining related activities, with a maximum disturbed area in any one year of 12,439 acres. The significance of impacts associated with this level of development would be similar to the impacts described for the low level production scenario. Of particular interest would be the loss of cropland from the Alton lease area. The amount of grassland converted would be approximately four times greater for the medium scenario than the low scenario. Therefore, the significance of the loss of cropland for the medium scenario would be greater.

A significant indirect effect associated with the development for the medium scenario is the conversion of land to urbanized uses due to population increases associated with coal development. Table 4-27 summarizes the estimated acreage needed for coal-related growth of the communities in the study area. As shown, most communities have sufficient vacant land to physically accommodate baseline and low production level growth (disregarding other possible factors such as unwillingness of current owners to develop or sell). However, the medium scenario would in many cases require expansion of communities (i.e., 3,856 acres for New Town). The significance of such expansion would vary, but the proximity of scarce cropland to many communities would cause conflicts over such expansion.

Mitigation Measures. Land use conflicts related to coal development and transportation should be reduced by avoiding sensitive areas with pipeline and railroad rights-of-way. The corridors have sufficient space to allow the transportatin rights-of-way to avoid communities by a mile or more. Rail crossings of major recreation and emergency access routes could be grade separated. Scarce croplands and privately owned lands should be avoided in most corridor segments to mitigate adverse impacts associated with land use conflicts.

Transportation

Impacts. As shown in Table 4-28, at the the medium production level, the P.M. peak hour vehicle generation from the North Kaiparowits lease area would be expected to total 2,160. In the vicinity of Escalante, U-12 has a Level of Service B standard of 500. Therefore, it is expected that during the periods of mine worker shift changes, extensive traffic congestion would occur on U-12 between Tropic and Escalante if dependence is placed solely on personal autos for transporting employees to the mines. During the morning and later afternoon shift changes, the influx of mine worker traffic at the projected volume levels would

TABLE 4-28

PROJECTED HIGHWAY PEAK-HOUR TRAFFIC DEMAND
MEDIUM COAL PRODUCTION LEVEL

Highway Location	Projected Baseline Hourly Demand[1] Estimates	Coal Development Generated Auto and Truck Traffic[2]	Total Peak-Hour Demand	Level of Service B Volumes[3]	Peak-Hour Demand Service Volume B Ratio
U-12 West of Escalante	215	2,160	2,375	500	4.75
U-12 West of Cannonville	165	340	505	540	0.94
U.S. 89 North of U-12	470	340	810	750	1.08
U.S. 89 South of U-12	470	290	760	720	1.06
U.S. 89 South of Glendale	520	70	590	465	1.27
U.S. 89 North of Kanab	425	75	500	800	0.63
U.S. 89 East of Kanab	550	455	1,005	735	1.37
U.S. 89 West of Glen Canyon City	305	455	760	735	1.03
U.S. 89 East of Glen Canyon City	305	455	760	735	1.03
U-14 West of U.S. 89	175	---	175	335	0.52

Source: ERT Project Team
[1]Baseline hourly demand for recreation season travel.
[2]Truck volumes represent "worst-case" facility loadings based on possible haul route destinations.
[3]Level of Service B volumes from Utah Department of Transportation

create an impedance to the recreation traffic on U-12. This impact would be most pronounced between Bryce Canyon and Escalante.

Assuming use of both Routes 136a and 136b, traffic from the Alton lease area would distribute both west and south. The major area of concern on U.S. 89 west of Alton is the segment from U-9 to U-14. The projected P.M. peak hour volume of 590 would exceed the Level of Service B standard of 465 vehicles per hour. It is expected that some reduction in operating speeds would result. Because of the auto composition of the generated traffic from the Alton lease area, no severe back-up on the long vertical grades would be expected.

Of the 4,825 vehicle trips generated from South Kaiparowits during the PM peak hour, approximately 75 percent are expected to originate from the planned New Town west of Glen Canyon City and 6 percent from Glen Canyon City itself. Assuming that a roadway connection would be provided directly from the New Town to the mine access roads, the vehicle impact from the South Kaiparowits lease area on U.S. 89 is expected to total approximately 910 vehicles in the peak hour. Half of the 910 vehicles are expected to use U.S. 89 from Kanab, with the remaining 455 vehicles using U.S. 89 from Page, Arizona. The resulting total peak- hour traffic loading of 760 (recreation traffic plus coal development generation) would only slightly exceed the Level of Service B standard of 720 on U.S. 89.

The combined impact of the recreation travel and coal development traffic from both Alton and South Kaiparowits would result in a total PM peak-hour traffic volume of 1,005 on U.S. 89 just east of Kanab (segment 89f). With a Level of Service B standard of 735, the projected traffic loading on U.S. 89 of 1,005 would probably result in reduced operating speeds with periods of vehicle back-ups during the AM and PM peak hours.

At the 54 MTY production level, truck activity would be minimal and, therefore, is not expected to be a significant factor relative to vehicle operating safety. Because of the projected level of mine employ ment, 200 to 225 additional accidents are expected to occur on an annual basis. The unit coal train operations would result in traffic flow delays and create a potential of vehicle-rail accidents (see Transportation Impacts).

Localized increases in traffic demand due to non-work trip making by mine worker family members and service industry activity for the communities expected to experience the largest population growth is summarized in Table 4-29. These traffic levels would alter the rural character of these small towns and cause significant increases in congestion and pedestrian hazards.

TABLE 4-29

COAL DEVELOPMENT INDUCED TRAFFIC ESTIMATES - 1995 MEDIUM COAL PRODUCTION LEVEL, NON-WORK RELATED TRIPS

Community	Coal Develpment Induced Daily Round Trips (Non-Work Travel)
Escalante	7,600
Tropic	5,500
Cannonville	2,600
Henrieville	950
Panguitch	2,400
Kanab	3,900
Glen Canyon City	2,200
New Town	36,900
Page	4,600

Mitigation Measures.

- Physical roadway improvements including construction of additional travel lanes, climbing lanes, turning lanes, and pavement resurfacing would facilitate operating safety and prevent roadway deterioration. In other coal development areas in Utah, such improvements have been financed in part by advance tax payments from coal companies.
- Traffic management strategies that could help reduce the coal development traffic impacts include mine worker ride-sharing through use of carpools, vanpools, and buspools. High occupancy vehicle commuting would help reduce the level of coal- generated traffic demand. Depending on worker participation in ride-sharing, commuter traffic volumes could be reduced between 25 and 75 percent.
- Possible use of staggered work horns among individual mines to spread out the peak period communter demand.
- Traffic control by police or mine security personnel during the AM and PM peak hours at the key intersections of the mine access road and the regional highway system would facilitate safe and efficient traffic operation.
- For at-grade rail crossings of regional highways, operational safety would be increased through use of advance signing, automatic gates, and crossing flashing lights.

Socioeconomics

Population projections for the medium level of coal development for the year 2000 are illustrated in Table 4-25. See Appendix K for other years. Population effects at this development level would be very significant for most communities with population increases ranging to almost 13 times the baseline population in Cannonville. Table 4-25 assumes development of a New Town of approximately 31,000 people. Effects on other communities would be expected to be much more severe if the New Town were not developed.

Mining at the medium level would provide an estimated 13,130 permanent jobs after construction of transportation facilities was completed. This increase in mining employment would significantly alter the employment structure of the study area with mining becoming the dominant export sector in the economy of the region. The estimated direct effect of this employment on the local economy would be an increase of $25 million (1980 dollars) annually in mining wages and salaries. No estimate has been made of secondary employment or income effects. With such a large number of new workers receiving above average incomes, the problem of price increases for goods and services discussed under the low scenario would be substantially aggravated such that current residents living on fixed incomes would be more severely affected.

Both Kane and Garfield Counties would face needs for capital improvements for hospitals, solid waste disposal facilities, and

roads. Garfield County would need additional general government office space and Kane County would need additional airport improvements. None of these would pose serious front-end financing problems. For reasons discussed previously and in the Socioeconomics Technical Report (Five-County 1980), county per capita expenditures would decline and per capita revenues would increase. At the medium coal development level the resulting revenue surplus would be substantial, reaching several million dollars per year for each county by the 1990s.

All communities studied would face adverse fiscal impacts as described under the low scenario but to a much greater degree of severity. In several cases projected operating and maintenance expenditures would be over four times greater than revenues at current tax and fee rates. See the Socioeconomics Technical Report (Five-County 1980) for details. Community capital improvement needs would be much greater in keeping with the substantially larger populations. Consequently, the front-end financing problems would be much more severe for necessary services such as domestic water, wastewater treatment and schools (Five-County 1980).

Beaver and Washington Counties and impacted communities within them would experience minor revenue shortfalls during the relatively brief transportation construction period. At the county level, small surpluses would develop with completion of rail facilities. A relatively small short-term "boom-bust" cycle would be expected in communities experiencing only transportation construction impacts.

Socio-Cultural

Impacts. Coal production of 54 MTY would result in classic "boomtown" conditions in Garfield and Kane Counties. Because of the magnitude of the growth and the rapidity with which it would occur, local community institutions are not likely to be able to adjust adequately to the changes as they occur. As a consequence, there would be significant increases in social problems, such as local crime rates, truancy and delinquency, increased drinking and drug abuse, and more frequent occurrences of family problems. Most of the local communities are simply not equipped to handle this rate and magnitude of growth without extensive strain and stress.

Many of the negative socio-cultural impacts would be unavoidable. Local communities would not be able to meet many of the demands placed on them for new services and facilities, at least initially. No matter how much advance planning occurs, there would be increased cultural conflict and other social problems. The increase in social problems and rapidly inflating costs of living would especially impact older residents who cannot benefit economically from the development, but who would bear a disproportionate share of its costs.

Mitigation Measures. There is probably no way to completely mitigate the negative socio-cultural impacts associated with the magnitude of growth projected under the two highest alternatives. However, much can be done with advance planning which would allow the communities to keep some control over the nature and type of growth that occurs. Public meetings and planning sessions would allow the public to express specific concerns and suggest specific solutions. The concentration of a majority of the new population in a new community would greatly aid existing communities. However, such an effort would require large amounts of front-end monies if it were to be successful.

Noise

Impacts. Under the medium production scenario, coal would be transported by rail or slurry pipelines. The slurry pipelines are expected to have minimal noise impact because the crusher and pumping facilities would be located in the lease areas and away from population centers. The rail lines would pass sensitive receptors near Glen Canyon City (pronghorn fawning area), Mt. Sutton (elk range), and near cities along the route. Traffic volumes would be low enough to keep noise impacts below the significant level. Further discussion on these impacts can be found under the high production scenario.

Mitigation Measures. Noise impacts could be mitigated if the following mitigation measures were implemented:

- Rail lines should be routed to provide adequate noise attenuation (45 dbA maximum night-time level) at sensitive receptors such as hospitals.
- Noise attenuation of approximately 10 dBA may be expected from muffler installation on locomotives.
- Grinding of train wheels and rails would reduce roar noise by reducing irregularities. Differences of approximately 6 dBA between noise levels for ground and unground rails have been reported.

High Scenario: Coal Production of 84 MTY, Slurry Pipeline and Railroads

For some environmental elements, the overall impacts associated with the high production scenario would be basically the same as the impacts described for the medium and low production scenarios with the exception that the land surface areas affected would be much greater. When appropriate, reference is made back to the description of impacts for the appropriate production scenario.

The mitigation measures and assumptions for the high production scenario are similar to those described for the low and medium production scenarios. Therefore, unless additional mitigation measures or assumptions are presented with this scenario, the reader should refer back to the specific mitigation measures and assumptions presented for each environmental element under the low and medium production scenarios.

Impacts to certain environmental elements would not be significantly different than impacts described for the low and medium production scenario. Therefore, the following elements are not addressed under this scenario:

- Paleontological Resources
- Native American Sacred Cultural Resources
- Visual Resources
- Socio-Cultural

Air Quality

Impacts. Projected unmitigated emissions from mine, transportation, and urban sources associated with this scenario would not be anticipated to result in violation of any air quality standards for any pollutant except TSP. On the local scale, unmitigated mine emissions at all three lease areas would exceed both PSD increments and NAAQS for TSP (Table 4-15). Specifically the unmitigated mine emissions would exceed applicable Class I TSP standards by a factor of 20 and NAAQS by 2 to 5 times. Unmitigated rail coal blow-off would exceed TSP, PSD Class II increments at levels above 10 MTY hauled in a single corridor. The annual SO_2 Class I PSD standard would be approached at rail coal haul levels above 45 MTY in the Alton-Bryce Canyon area.

The worst-case year for potential air quality degradation would occur midway in the lease life when urban areas reach maximum population and Alton surface mining is still in progress. In the absence of coal development, worst-case background regional particulate loading would increase about 1.5 to 3 times, as the population in the area doubles. Cumulative regional concentration effects would result from railroad construction at both the North and South Kaiparowits lease areas, and from pipeline construction at the Alton lease area. Assuming the construction of the Warner Valley Power Plant, the cumulative concentrations without coal development would be about 50 percent as large as the combined concentrations associated with mining, coal transport, and large urban growth. During the construction period, local TSP concentrations would exceed appropriate standards as previously described for the medium scenario.

On the regional scale, unmitigated emissions would cause ambient 24- hour TSP concentrations exceeding 200 $\mu g/m^3$ near the North and South Kaiparowits lease areas and exceeding 300 $\mu g/m^3$ in the autumn at South Kaiparowits. Beyond 20 miles downwind of the major sources, background RSP levels would be about 3 times the baseline (no coal) levels projected for the year 2000. At that time, the effects of increased population and unmitigated mining would increase background RSP levels to about 8 times their present value (Figure 4-19).

In the high scenario, particulate emissions from the New Town in eastern Kane County would become significant causing an increase of 38 $\mu g/m^3$ over presently existing values and approaching the secondary NAAQS standard. Regional scale concentrations of NO_x and SO_2 are low and below the applicable standards.

Mitigation Measures. Implementation of mitigation measures would reduce the air quality impact and alleviate any potential air quality standard violations. Several mitigation measures could be utilized to reduce the air quality impact. Appendix J presents a comprehensive list of mitigation measures which could be incorporated. However, some of the specific mitigation measures presented for the medium scenario would be effective in mitigating local TSP emissions for each lease area, regional RSP values, and train-related coal blow-off emissions for this scenario.

A reduction of 88 percent of the unmitigated TSP values would alleviate potential local TSP standard violations for the North Kaiparowits lease area. After 2001 when the Alton coal lease area would shift to underground mining, the 88 percent mitigation level would be sufficient to prevent violations of ambient air quality standards (Table 4-16). However, the

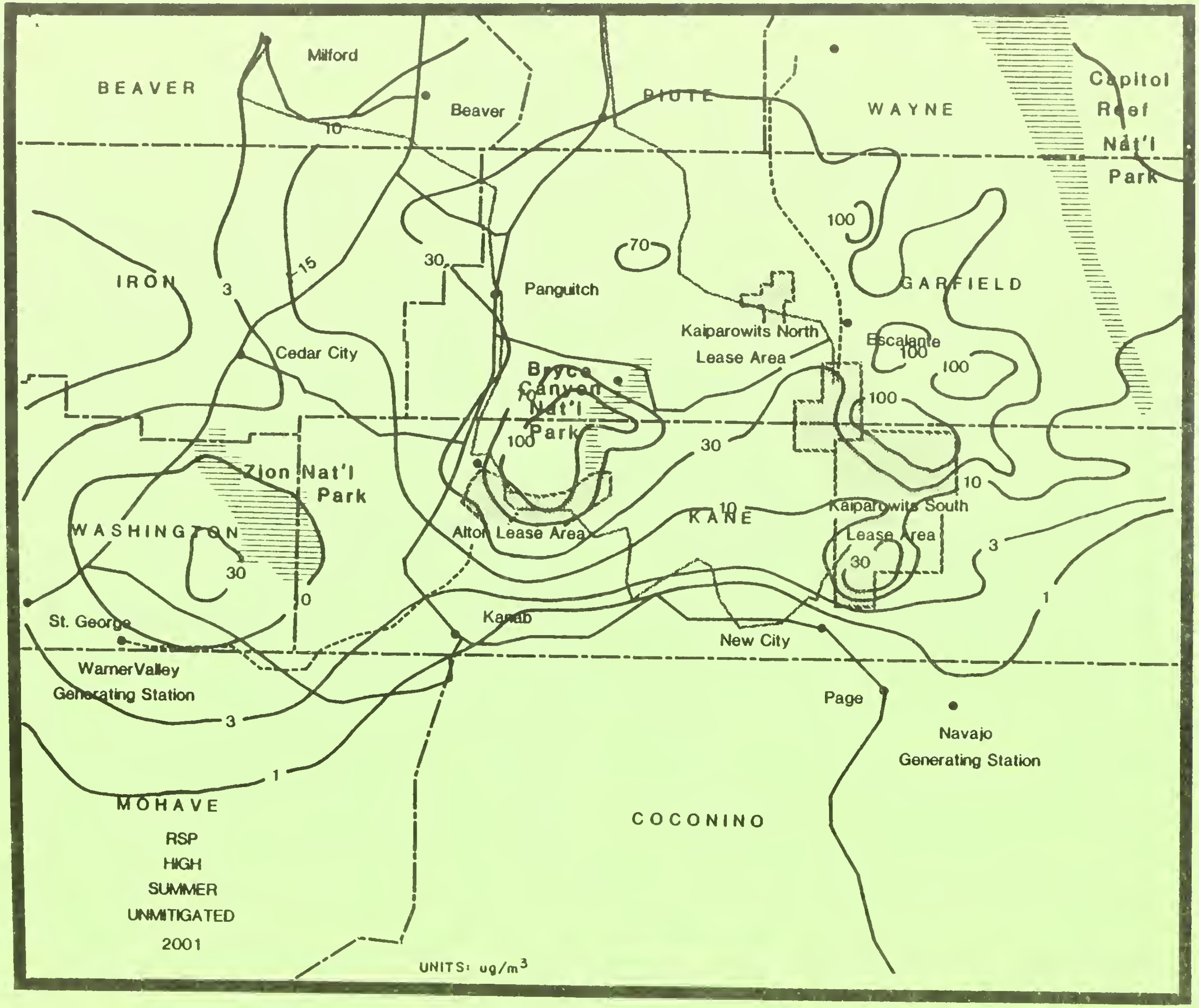


Figure 4-19. High Production RSP Concentrations Isopleths (Unmitigated).

additional mitigation to 94 percent as described in the medium scenario would be required to meet the PSD annual Class I and the 24-hour Class I and II TSP standards. In the South Kaiparowits lease area, a 96 percent reduction in emissions would be required to reach Class II 24-hour TSP standards.

From a regional standpoint, implementation of the mitigation measures previously identified would be effective in reducing the unmitigated regional RSP emissions to the appropriate levels. Mitigated regional emissions for the high scenario are presented in Table J-10 in Appendix J. The mitigation measures would decrease regional RSP levels within 20 miles of the mines by a factor of 20 and reduce distant downwind concentrations by a factor of 3. Regional RSP concentration isopleths for this scenario are presented in Figure 4-20.

Visibility

Impacts. In the high production scenario, unmitigated coal production reduces the mean geometric visual range significantly. In 2001 during the operation phases at Alton and South Kaiparowits, visual range from Bryce Point to Navajo Mountain would be reduced from 200 to 49 kilometers (124 to 30 miles) due to pit and haul road emissions at Alton, haul road traffic at South Kaiparowits, and emissions from the New Town in eastern Kane County. Mitigation at the 88 percent level at the mines would make it possible to achieve a visual range of 177 kilometers (110 miles), as in the medium scenario. The overall reduction in visual range from the present value would be around 12 percent along that vista in the mitigated case. Mitigating the visibility degradation above that level would entail more effective controls of the urban emissions, since the regional background begins to become as important as the mitigated mine effects.

The vistas from Lava Point and Hopi Tower would be unchanged from the low scenario values in the high scenario. The Langdon Peak vista from Bryce Point is estimated to be decreased by about 60 percent in visual range between the unmitigated low and high scenarios. The corresponding decreases for the shorter Cottonwood Peak and Table Cliffs vistas would be under 30 percent. Mitigation would return the visual range along these vistas to their low scenario values are not projected to be significantly impacted.

For the 24-hour cases which were investigated at a given humidity and sun angle, visibilities along every vista would be greater in the spring and lower in the fall than the summer case upon which the vista comparisons were based. This is particularly true for the Bryce Point- Navajo Mountain vista which was influenced by southerly flow over Lake Powell during the autumn.

Refer to the low scenario section for a photographic comparison of visibility changes.

Topography, Geology, and Minerals

Impacts. The impacts of coal production of 84 MTY, such as (1) volume of nonrecoverable coal as a result of mining, (2) area modified by surface mining, (3) area of subsidence from underground mining, (4) area possibly affected by rockslides and small landslides, and (5) volume of coal possibly lost by coal bed fires, are similar to those of coal productions of 5 MTY and 54 MTY with the major exception that the volume of coal and the areas affected would be much greater. The volume of nonrecoverable coal would range from about 72 MTY in the underground mines and about 0.77 MTY in the surface mines for the first 20 years of production to about 81 MTY and 0.19 MTY for the last 16 years. The volume of limestone needed for rock-dusting in the underground mines would range from about 0.40 MTY for the first 20 years to about 0.45 MTY for the last 16 years.

Soils

Impacts. Soil impacts are similar to those described under the low production level scenario except that the acreage disturbed would increase to approximately 23,563 acres on the coal lease areas, 5,822 acres as a result of expansion of existing communities and 3,856 acres for New Town.

Water Resources

Impacts. Impacts on water resources for high level coal production would be the same in the Alton area as for the production of 54 MTY since water requirements would not change. Water requirements in the North Kaiparowits lease area would decrease from medium production level as coal would be transported by rail rather than slurry pipeline resulting in a much smaller decrease in the water taken from the Navajo Sandstone aquifer. The cone of depression out to the 1-foot drawdown level would occur at a radius of 10.9 miles from the center of either of the well fields. Production water demand would increase in the South Kaiparowits lease area.

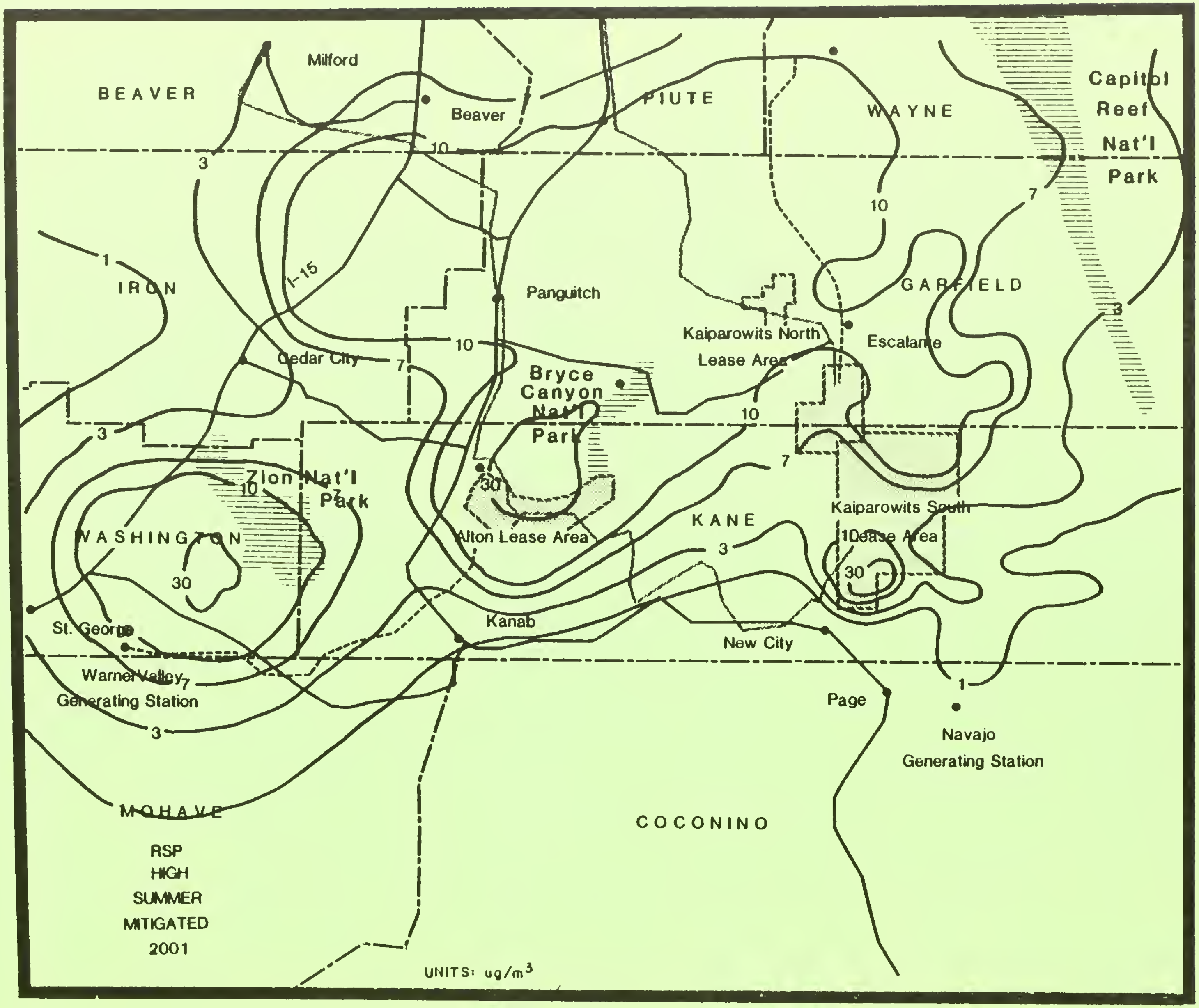


Figure 4-20. High Production RSP Concentrations Isopleths (Mitigated).

This water would come from Lake Powell resulting in no significant environmental impacts. Salinity would increase by 0.39 mg/l at Imperial Dam. This change would be negligible. Domestic water demands would increase with the increased population as was identified on Table 4-26. Sources of this water would be the same as those identified under the medium production scenario.

Vegetation

Impacts. It is estimated that approximately 23,563 acres would be removed from production over the life of the coal lease areas (Table 4-19). An estimated 871 animal unit months (AUMS) per year would be lost from lease areas. Assuming that 13 years would be required before livestock can graze reclaimed areas, a total of 11,323 AUMS would be lost at this level of production. The estimated 871 AUMs lost from the lease areas nearly 2 percent of the available Federal AUMs in the Escalante, Paria, and Zion Planning Units (USDI, BLM 1980). Expansion of existing communities would consume an additional 5,822 acres of land over baseline conditions (Table 4-27). AUMs lost are unquantifiable. The development of New Town would consume 3,856 acres of desert shrub plant community and result in the loss of 96 AUMs per year as would occur under the medium production level scenario.

The chances that mining would disturb habitats of candidate threatened or endangered plant species is evaluated as moderate to low because of the small ratio between disturbance area and available area contained within the three coal lease areas (see discussion under 54 MTY). Riparian areas beyond the limits of coal mining areas could b e adversely affected by diversion of surface flows and disruption of shallow aquifers.

Wildlife

Impacts. Wildlife impacts are similar to those described earlier. The severity of impact would increase in relation to the size of the area disturbed (23,536 acres for coal production, Table 4-19; 9,678 for urbanization, Table 4-27 and an unquantifiable amount for transportation). Secondary effects of increased regional human population would be even more pronounced. Reported highway mortality would increase by 186 percent (316 deer per year over current conditions). Aquatic impacts would be similar to those described under the medium production level scenario.

Archaeological Resources

Impacts. Development of coal at the high scenario level would be expected to directly affect 408 archaeological sites (Table 4-21). In addition, construction of either the coal slurry pipelines or railroads would directly impact from 2 to 25 additional sites per corridor segment (would be dependent upon specific corridor segment). Impacts to cultural resources would also result due to construction of limestone quarries and the New Town at East Clark Bench. These indirect effects of coal development impacts would also impact an additional 146 cultural resource sites. Impacts of this scenario on archaeological sites on or nominated to the National Register of Historic Places would be similar to those discussed under the medium production scenario.

From a cumulative standpoint, coal development and transportation impacts for the high scenario would either directly or indirectly impact over 475 archaeological sites. The overall significance of this impact would be dependent upon the value of the sites affected.

Land Use

Impacts. Surface and underground coal development for all lease areas would result in total conversion of approximately 23,563 acres of cropland, grassland, and forest land to mining and mining-related activities with a maximum disturbed of 14,024 acres in any one year. The significance of conversion of cropland to mining has been discussed in the medium production scenario and would be the same for this scenario.

As identified for the medium production scenario, the high scenario would indirectly affect conversion of land to urbanized uses. This is due primarily to population increases associated with coal development. Under this scenario, the population growth would require expansion of several towns. The expansion would also cause land use conflicts with scarce cropland.

Recreation and Resources

Impacts. Recreation traffic conflicts with coal-related traffic would be substantially more severe at the high production level than at the medium level (see Transportation Section for details). Effects of increased coal-related recreation visits are illustrated on Table 4-22. Adverse impacts to recreation facilities and use satisfaction, as

TABLE 4-30

PROJECTED HIGHWAY PEAK-HOUR TRAFFIC DEMAND
HIGH COAL PRODUCTION LEVEL

Highway Location	1980 Existing Hourly Demand[1]	Coal Development Generated Auto and Truck Traffic[2]	Total Peak-Hour Demand	Level of Service B Volumes[3]	Peak-Hour Demand Service Volume B Ratio
U-12 West of Escalante	215	4,440	4,655	500	9.31
U-12 West of Cannonville	165	650	815	540	1.51
U.S. 89 North of U-12	470	690	1,160	750	1.55
U.S. 89 South of U-12	470	350	820	720	1.14
U.S. 89 South of Glendale	520	150	670	465	1.44
U.S. 89 North of Kanab	425	215	640	800	0.80
U.S. 89 East of Kanab	550	710	1,260	735	0.87
U.S. 89 West of Glen Canyon City	305	710	1,015	735	1.71
U.S. 89 East of Glen Canyon City	305	670	975	735	1.33
U-14 West of U.S. 89	175	175	350	335	1.04

Source: ERT Project Team
[1]1980 Existing hourly demand for recreation season travel.
[2]Truck volumes represent "worst-case" facility loadings based on possible haul route destinations.
[3]Level of Service B volumes from Utah Department of Transportation

described under the low production scenario, would be increased by as much as 60 percent over the 54 MTY level. Visual quality and visibility impacts on tourism would b e the same as those at the medium production level.

Wilderness

Impacts. Wilderness effects would be similar to those at the low and medium production levels. National market demands strong enough to support 84 MTY of coal production would generate great pressure to permit coal development in the portion of the South Kaiparowits lease area proposed as a wilderness study area. Wilderness study areas, when finalized in November 1980, would preclude development of new rights-of-way for slurry pipelines and railroads within their boundaries until and unless they are dropped from wilderness consideration. See Map 3-8 for corridors which would be affected.

Transportation

Impacts. At the 84 MTY production level, the P.M. peak-hour vehicle generation from the North Kaiparowits lease area would be expected to total 4,440 exceeding the Level of Service B standard on U-12 of 500 to 540 vehicles per hour. Table 4-30 indicates the projected peak-hour traffic demand for the high level of production. Periods of pronounced traffic congestion with low speeds would occur on the two-lane facility. In the vicinity of Escalante, the projected peak-hour coal generated traffic would exceed the theoretical 2,000 vehicle per-hour capacity for two-lane roadways (Highway Research Board 1965).

TABLE 4-31

COAL DEVELOPMENT INDUCED TRAFFIC ESTIMATES - 1995
HIGH PRODUCTION LEVEL NON-WORK RELATED TRIPS

Community	Coal Development Induced Daily Round Trips (Non-Work Travel)
Escalante	14,900
Tropic	10,700
Cannonville	5,120
Henrieville	5,120
Panguitch	4,655
Kanab	4,855
Glen Canyon City	3,225
New Town	53,450
Page	6,565

Source: ERT Project Team

The Alton lease area employee vehicle generation would be the same as the medium production scenario vehicle generation. Because of the projected higher employment at the North and South Kaiparowits lease areas, the cumulative traffic volume loadings on U.S. 89 between Kanab and U-12 would be greater for the 84 MTY production level than at the 54 MTY alternative. The projected P.M. peak-hour volume of 670 vehicles on U.S. 89 between U-9 and U-14 would exceed the Level of Service B standard of 465 vehicles per hour. Reduced vehicle operating speeds with periods of traffic back-up could result, particularly in areas with long steep vertical grades. Similarly, the P.M. peak-hour traffic loading on segment 89c of 820 vehicles would exceed the Level of Service B standard of 720 vehicles per hour.

Of the 7,240 vehicle trips generated from South Kaiparowits during the P.M. peak hour, approximately 75 percent are expected to originate from the New Town west of Glen Canyon City and 6 percent from Glen Canyon City itself. Assuming that a roadway connection would be provided directly from the lease area to the New Town, the vehicle impact on U.S. 89 is expected to total approximately 1,380 vehicles during the P.M. peak hour. An estimated 710 vehicles of this total are expected to use U.S. 89 from Kanab , with the remaining 670 vehicles using U.S. 89 from Page, Arizona. The resulting total peak-hour traffic loadings (existing recreation traffic plus coal development generation) on U.S. 89 range from 975 to 1,260 vehicles, exceeding the Level of Service B standard of 720 for the facility.

The area just east of Kanab (segment 89f) is expected to experience the highest traffic loadings (1,260 vehicles) during the P.M. peak hour due to the cumulative effect of Alton and South Kaiparowits mine employee traffic. Reduced operating speeds with vehicle back-up would occur on this segment of U.S. 89 during peak commuter periods.

Due to the vehicle miles of travel generated by the coal development employee travel, an additional 350 to 370 additional accidents could occur on an annual basis. The unit coal train operations would result in traffic flow delays and create a potential for vehicle-rail accident occurrence (reference Appendix G).

Localized increases in traffic demand due to non-work trip making by mine worker family members and service industry activity for the communities expected to experience the largest population growth is summarized in Table 4-31. These increases in traffic would change the rural character of the towns and would cause a very significant increase in traffic congestion and pedestrian hazards.

Mitigation Measures. The need for the physical roadway improvements and traffic management strategies identified for the medium coal production level scenario is even greater for the high coal production level because of the increased traffic demand. Because of the magnitude of the coal development-generated traffic at the high production level, mitigation measures for identified transportation impacts could include the following:

- Upgrade U-12 from two to four travel lanes between Tropic and Escalante.

- Upgrade U.S. 89 (segment 89f) from two to four travel lanes between Johnson Canyon Road and Kanab.

- Provision of climbing lane on U.S. 89 by Glendale and U-12 through Red Canyon.

- Use of vehicle turning lanes at the intersections formed by mine access roads and regional highway facilities.

- Implementation of a comprehensive ride-sharing program for mine employees, including carpooling, vanpooling, and buspooling. Depending on worker participation in ride-slurry, commuter traffic volumes could be reduced between 25 and 75 percent.

- Possible use of staggered work hours among individual mines to spread out the peak period commuter demand.

- Use of police or authorized personal traffic control at the intersections of the mine access road and the regional highway system.

- Monitoring of roadways for areas of deteriorating physical conditions with quick response maintenance program.

Socioeconomics

Population projections for the high level of coal development for the year 2000 are illustrated in Table 4-25; for other years see Appendix K. Population effects at the high development level would be very significant for nearly all impacted communities. With the assumed development of a New Town with over 45,000 population, the high scenario community popula tions range from 1.5 times the projected baseline level to over 26 times the baseline level. Effects on Page, Arizona and Kane County communities would be much more severe without the New Town which was projected to absorb nearly half the total population increase.

Mining at the high level would provide an estimated 21,600 permanent jobs after completion of construction activities. A significant change in the employment structure of the study area would result in mining becoming the dominant export sector in the regional economy. The estimated direct effect of this employment on the regional economy would be an infusion of an estimated $431 million (1980 dollars) annually in mining wages and salaries. No estimate has been made of secondary employment or income effects. Adverse impacts on current residents living on fixed incomes, as discussed under the low and medium scenarios, would be significantly more severe under high level coal development conditions.

Capital improvement needs, as discussed under the medium scenario for Kane and Garfield Counties, would be significantly increased with high level coal development. County level revenue surpluses as explained under the medium scenario and in the Socioeconomics Technical Report (Five-County 1980) would be substantially greater than those projected under the medium scenario, approaching $8 million annually for Garfield County and $17 million annually for Kane County (1980 dollars) before 1995 (Five-County 1980).

All impacted communities would experience adverse fiscal impacts as described under the low and medium scenarios. For Garfield County communities, the annual revenue shortfalls would be significantly greater than those projected for the medium development level because of increased population levels. The worst-case would be Escalante where the projected shortfall would exceed $1 million per year (1,980 dollars) by 1995. Kane County shortfalls typically are projected at the same level as for the medium level of coal development because the population projections are the same for most communities under both medium and high scenarios (Five-County 1980). Community capital improvement needs would be related to population levels, so front-end financing problems under the high scenario would be much more severe than under the medium scenario for most Garfield County communities but would be approximately the same under both scenarios for most Kane County communities.

Beaver and Washington County impacts would be approximately the same as described under the medium scenario.

Mitigation Measures

See discussions under the low and medium scenario.

Noise

Impacts. The largest amount of rail traffic would occur in the high scenario on the route

from South Kaiparowits to Milford, where 45 million tons of coal per year would be carried by 21 trains per day. This implies a train pass-by every 35 minutes. At 40 mph, sound exceeding 65 dBA at 100 feet from the track would be expected to persist for 3 minutes per train, or slightly over 2 hours per day. This is classified as acceptable by HUD standards. Night-time sound propagation is considerably more effective than daytime. Under worst-case conditions, sound levels at a distance of 3 miles from the tracks could be as high as 55 dBA. This would be above typical maximum permissible night-time noise levels of 45 dBA for hospital zones.

Increased urban growth resulting from coal development would result in increased yearly average noise levels for the communities involved. The greatest change in the urban noise environment would likely occur near Glen Canyon City, where the population (including New Town) would increase from near 200 to about 48,000, and yearly average noise levels would rise from approximately 40 dBA to 50 dBA.

CHAPTER 5

COORDINATION

PUBLIC COORDINATION

Meetings

A series of public meetings were held in five locations in Utah and Arizona in September 1979 to introduce the public to the Kaiparowits Coal Development and Transportation Study, to answer questions concerning the study, and to collect local information.

- Salt Lake City, Utah September 24, 1979

  Approximate attendence was 45 and included representatives of Union Pacific Railroad, El Paso Natural Gas, KRCL Radio, Utah Audubon Society, Utah Wilderness Society, Brine Shrimp Alliance, Senator Orrin Hatch's Office, Nevada Power Company, Mono Power Company, Kane County Commission, Utah Power and Light Company, University of Utah Natural Resources Law Forum, and Wyoming Bureau of Land Management (BLM).

  Public concern was primarily in regard to the effects of coal production and transportation on air quality in the region; the desire for economic stimulation from development of the region's coal reserves; and protection of the region's scenic, recreational, and wilderness resources.

- Cedar City, Utah September 25, 1979

  Approximate attendence was 25, including representatives of the Five County Association of Governments, Dixie National Forest, Friends of the Earth, Utah Division of Wildlife Resources, Source, Spectrum, 5M Inc., and the League of Women Voters.

  Concern was expressed as to whether there was a current need for development of the Kaiparowits coal reserves and the effects of development on the environment of the region and the quality of life.

- Kanab, Utah September 26, 1979

  The two primary concerns expressed were (1) the effect of surface mining in the Alton coal field on groundwater recharge to Kanab and Johnson Creeks, and (2) water transport out of the area by slurry pipelines.

A Kane County Commissioner made a statement expressing the following concerns:

1. The county favors economic growth; however, an expanded tax base is needed prior to a large increase in population.
2. The county favors additional analyses of the effects of water usage for mining and transportation.
3. The county wants planned growth in order to maintain the quality of life.
4. The county would need front-end money from industries planning development.
5. The county is concerned about effects on air quality, property costs, and transportation facilities.
6. The county would like a more secure economic base than the tourist industry.

- Page, Arizona September 27, 1979

  Approximate attendance was 25 and included representatives of the National Park Service (NPS), Page City Council, Utah Division of Wildlife Resources, Lake Powell Chronicle, KRGE Radio, and the Page Paragraph.

Major concerns expressed included the effect of Kaiparowits coal development on the city, the need to develop the coal at this time, the ability of the Five County Association of Governments to analyze adequately the effects of development on Page and northern Arizona, and the possibility of a railroad constructed between Page and Flagstaff.

- Flagstaff, Arizona September 28, 1979

Approximate attendence was 30 and included representatives from the NPS, Northern Arizona Council of Governments, and the Coconino County Board of Supervisors.

Interest was expressed in the methodology and rationale used to define transportation corridors in northern Arizona and the parameters to be examined in the socioeconomic study. Concern was shown as to whether the Five County Association of Governments could conduct an impartial socioeconomic study in northern Arizona.

Mailouts

Approximately 300 copies of the Kaiparowits Coal Development and Transportation Study Update were distributed on April 15, 1980. The mailing list included names supplied by the BLM, the names of interested individuals and agencies collected during the five public meetings, and from other contacts established during project-related activities. The update presented a summary of progress made on the study and described the activities scheduled for the remainder of the project. Public input was encouraged to avoid any significant omissions or errors in the study.

AGENCY COORDINATION

During the preparation of this report, the project team communicated with various Federal, state, and local agencies; interest groups; and individuals. The communications varied from formal written correspondence to informal personal contacts and telephone calls.

Federal
U.S. Department of Agriculture
Forest Service, Salt Lake City
Intermountain Forest and Range Experiment Station, Logan
Dixie National Forest, Cedar City, Escalante, Panguitch
Fishlake National Forest, Richfield
Manti-LaSal National Forest, Price

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Climate Center, Asheville
Air Resources Laboratories, Idaho Falls
National Weather Service, Western Region Headquarters, Salt Lake City
Nuclear Support Unit, Las Vegas

U.S. Department of Defense
Department of the Army
Dugway Proving Ground, Utah

U.S. Department of the Interior
Bureau of Land Management
Arizona State Office
Arizona Strip District, St. George
Vermillion Resource Area
California State Office, Sacramento
Utah State Office
Cedar City District
Escalante Resource Area
Kanab Resource Area
Richfield District
Sevier River Resource Area

Bureau of Reclamation
Utah State Office, Salt Lake City

Fish and Wildlife Service
Utah State Office, Salt Lake City

Geological Survey
Utah State Office, Salt Lake City

National Park Service
Bryce National Park
Canyonlands National Park
Capitol Reef National Park
Denver Air Quality Center
Glenn Canyon National Recreational Area
Grand Canyon National Park
Wupatki National Monument
Zion National Park

Office of Surface Mining

U.S. Environmental Protection Agency
Region VIII, Denver
Region IX, San Francisco
Research Triangle Park, North Carolina

State

Arizona Department of Game & Fish, Northern Region
Utah Department of Development Services
Division of State History
Utah Department of Economic & Community Development
Utah Department of Natural Resources
Division of Parks & Recreation
Iron Mission State Historical Monument
Division of State Lands & Forestry
Division of Water Resources
Outdoor Recreation Agency
Geological & Mineral Survey
Division of Wildlife Resources
Utah Department of Social Services
Division of Health
Bureau of Air Quality

Utah Department of State Planning
Utah Department of Transportation
Utah Energy Office
Utah Office of the Solicitor

Elected Officials
U.S. Senators
Jake Garn, Utah
Orrin Hatch, Utah

U.S. Representatives
Gunn McKay, Utah
Dan Marriott, Utah

U.S. State Senators
Moroni L. Jensen
Ivan M. Matheson
Glade Sowards

Utah State Representatives
Mike Dmitrich
S. Garth Jones
Charles Hardy Redd

Utah County Commissioners
Sterling Griffiths
H. Dell LeFeyre
Ted Johnson
Merrill MacDonald

Utah Mayors
Walter T. Axelgard, Price
Gary S. Hansen, Payson
Ted Wilson, Salt Lake City

Educational

University of Utah
Utah State University
Fish and Wildlife Cooperative Research Unit
Department of Wildlife Biology
Department of Range Science

Native American Groups

Navajo Nation
Cedar City Paiutes
Kaibab Paiutes
Kanosh Paiutes
Koosharem Paiutes
Shivwits Paiutes
San Juan Paiutes (Willow Spring & Navajo Mountain groups)

Other

American Association of Railroads
American Coal Company
Atchison, Topeka & Santa Fe Railway Co.
Coastal States Coal Company
Colorado Open Space Council
Consolidation Coal Company
Denver & Rio Grande Western Railroad Company
El Paso Natural Gas
El Paso Coal Company
Friends of the Earth
Hiko Bell Mining & Oil
Jesse H. Knight
League of Women Voters
Mid-Continent Resources
Nevada Power Company
Peabody Coal Company
Shakespeare Coal Company
Sierra Club
Sierra Club Legal Defense
Six County Commissioners Organization
Slurry Transport Association
Southeastern Association of Governments
Sun Oil Company
Swister Coal Company
Union Pacific Railroad
Utah Association of Counties
Utah Energy Council
Utah International, Inc.
Utah Power & Light Company
Western Interstate Energy Board
Wilderness Society
Woods Petroleum Corporation

CHAPTER 6

APPENDICES

APPENDIX A

AIR QUALITY DATA

TABLE A-1
AMBIENT AIR QUALITY STANDARD

	National Standards[a] ($\mu g/m^3$)			
Pollutant	Averaging Time	Primary	Secondary	State of Arizona[b]
Oxidant (ozone)[c]	1-hour	235	d	160
Carbon monoxide	8-hour	10	d	10
	1-hour	40	d	40
Nitrogen dioxide	Annual	100	d	100
Sulfur dioxide	Annual	80	-	80
	24-hour	365	-	365
	3-hour	-	1300	1300
Suspended particulate matter	Annual (geometric mean)	75	60	75
	24 hour	260	150	150
Lead	Calendar Quarter	1.5	d	1.5
Hydrocarbons	3-hour	160	d	160

[a]National standards, other than that for ozone or those based on annual averages, are not to be exceeded more than once per year. The national ozone standard is not to be exceeded more than once per year based on a 3-year running average. National standards are the only standards enforceable in Utah.

[b]Not to be exceeded more than once per year.

[c]National standards specify ozone.

[d]Same as primary standard.

TABLE A-2

PSD INCREMENT

Pollutant	Averaging Time	Increments ($\mu g/m^3$) Class I	Class II	Class III
Sulfur Dioxide	Annual Average	2	20	40
	24-hour	5	91	182
	3-hour	25	512	700
Particulate Matter	Annual Average	5	19	37
	24-hour	10	37	75

TABLE A-3

Air Quality Monitoring Stations in Southern Utah

	Station Name	Location	County	Period of Record	Pollutants
Utah Division of Health Monitoring Sites	Cedar City(1)	Cedar City, Utah	Iron	1975-1978	TSP, SO_2
	Hurricane(2)	Hurricane, Utah	Washington	1977-1978	TSP, SO_2, NO_2
	Bullfrog Basin(3)	Near Lake Powell in Glen Canyon National Recreation Area, about 10 miles ESE of Capitol Reef National Park	Garfield	1971-1972 1975-1977	TSP, SO_2
Arizona Department of Health Services	Wah Weap(4)	Near southern end of Lake Powell about 5 miles NW of Page, Arizona	Coconino	1971-1978	TSP, SO_2, NO_2
	Page Airport(5)	Page, Arizona	Coconino	1973-1979	TSP, SO_2, NO_2, Lead
	Page Water[a](6) Tower	Page, Arizona	Coconino	1974-1979	TSP, SO_2, NO_2, O_3
Supplementary Monitoring Sites	St. George(7)	St. George, Utah	Washington	1976	TSP
	Leche-E(8)	4 miles ESE of Page, Arizona	Coconino	1972	TSP
	Nipple Bench(9)	15 miles NNE of Page, Arizona	Kane	7/74-2/75	SO_2
	Four-Mile Bench(10)	25 miles NNE of Page, Arizona	Kane	7/74-2/75	SO_2
	Warner Valley(11)	13 miles SE of St. George, Utah and 11 miles SE of Hurricane, Utah	Washington	11/74-10/75	TSP, SO_2, NO_2
	Cainesville(12)	15 miles S of Caineville, Utah	Garfield	8/74-9/74	TSP, SO_2, NO_2
	Fremont River(13)	12 miles SE of Caineville, Utah	Wayne	1974-1976 (3 seasons)	TSP, SO_2, NO_2, O_3
	Wayne County(14)	10 miles N of Caineville, Utah	Wayne	1974	TSP, NO_2

[a]Monitoring station operated by Salt River Project (SRP) but data available through Arizona Department of Health Services. The SRP equipment was originally located at the airport also; it was moved on 10 February 1977 to its present location at the city water tower.

TABLE A-4

Ambient Particulate Concentrations
Primary Sites

Site	Year	Concentrations ($\mu g/m^3$) Maximum 24-Hour Average	Second Maximum 24-Hour	Annual Geometric Mean
Cedar City	1975	226	176	47
	1976	189	170	56
	1977	151	132	51
	1978	262	245	47
Hurricane	1977	175	167	16
	1978	193	133	[a]20
Bullfrog Basin	1971	529	112	11
	1972	600	244	21
	[b]1975	183	151	14
	1976	120	115	15
	1977	423	258	17
Wah Weap	1971	400	269	22
	1972	339	226	28
	1973	159	113	15
	1974	99	81	13
	1975	324	175	19
	1976	118	114	23
	1977	661	322	24
	1978	186	143	11
Page Airport	1973	202	...	52
	1974	139	127	48
	1975	160	127	44
	1976	156	181	41
	1977	220	141	37
	1978	61	46	[a]25
	1979	191	131	34
Page Water Tower	1974	541	506	38
	1975	742	421	41
	1976	556	394	47
	1977	543	213	35
	1978	137	120	25
	1979	83	75	34

[a]Incomplete data.

[b]No data for years 1973 and 1974.

[c]Monitor operated by SRP moved from airport to city water on 10 February 1977.

TABLE A-5

Variations of Short-Term Particulate Standards
Primary Sites

Site	Year	Number of 24-hour Averages Exceeding	
		[a]260 $\mu g/m^3$	[b]150 $\mu g/m^3$
Cedar City	1975	0	6
	1976	0	2
	1977	0	1
	1978	0	1
Hurricane	1977	0	2
	1978	0	1
Bullfrog Basin	1971	1	1
	1972	1	3
	1975	0	2
	1976	0	0
	1977	1	5
Wah Weap	1971	2	3
	1972	1	6
	1973	0	1
	1974	0	0
	1975	1	2
	1976	0	0
	1977	3	5
	1978	0	1
Page Airport	1973	0	...
	1974	0	0
	1975	0	1
	1976	0	...
	1977	0	1
	1978	0	0
	1979	0	1
Page Water Tower	1974	<2	<2
	1975	...	...
	1976	...	...
	1977	1	...
	1978	0	0
	1979	0	0

[a]Secondary standard.
[b]Primary standard.

TABLE A-6

Ambient Sulfur Dioxide Concentrations
Primary Sites

Site	Year	3-Hour Average Max. ($\mu g/m^3$)	3-Hour Average 2nd Max. ($\mu g/m^3$)	24-Hour Average Max. ($\mu g/m^3$)	24-Hour Average 2nd Max. ($\mu g/m^3$)	Annual Arithmetic Mean ($\mu g/m^3$)
Cedar City[a]	1975	1100	1022	393	288	43
	1976	1808	1703	760	576	86
	1977	1467	1179	550	472	66
	1978	996	917	524	472	52
Cedar City #2	1977	131	79	52	26	26
Cedar City #3	1977	79	52	26	0	0
Hurricane	1978	26	0	0	0	0
Bullfrog Basin	1975	0	0	0	0	0
	1976	77	52	26	0	0
Wah Weap	1975	77	52	26	0	3
	1976	105	77	26	0	0
	1977	131	52	52	26	0
	1978	52	26	26	0	0
Page Airport	1973	...	...	11	...	2
	1974	...	...	22	20	8
	1975	...	...	22	22	7
	1976	...	...	35	20	6
Page Water Tower	1974	117	94	13	8	<1
	1975	...	...	16	11	<1
	1976	...	...	35	16	1
	[b]1977	...	...	2	2	1
	1978	...	...	10	1	3
	1979	...	...	16	9	1

[a]Original Cedar City monitor was located adjacent to the power boiler at the College of Southern Utah and experienced direct plume interaction most of the time. Monitors #2 and #3 were activated to better measure ambient SO_2 concentrations in Cedar City. (Telephone communication with Mr. Robert Dalley, Utah Bureau of Air Quality, 19 May 1980.

[b]Monitor operated by SRP moved from airport to city water tower on February 1977.

TABLE A-7

Violations of Short-Term Sulfur Dioxide Standards
Primary Sites

Site	Year	Number of Occurrences 3-Hour [a](1300 $\mu g/m^3$)	24-Hour [b](365 $\mu g/m^3$)
Cedar City[c]	1975	0	1
	1976	6	7
	1977	1	4
	1978	0	3
Cedar City #2	1977	0	0
Cedar City #3	1977	0	0
Hurricane	1978	0	0
Bullfrog Basin	1975	0	0
	1976	0	0
Wah Weap	1975	0	0
	1976	0	0
	1977	0	0
	1978	0	0
Page Airport	1973	...	0
	1974	0	...
	1975	...	0
	1976	...	0
Page Water Tower	1974	0	0
	1975	...	0
	1976	...	0
	1977	...	0
	1978	...	0
	1979	...	0

[a]Secondary standard.

[b]Primary standard.

[c]Number of occurrences approximate; based on total number of hours the standards were exceeded.

TABLE A-8

Ambient Nitrogen Dioxide Concentrations Primary Sites

Site	Year	Concentrations (μg/m³) Maximum Average	Maximum 24-Hour	Annual Arithmetic Mean
Hurricane	1977	56	...	2
	1978	38	...	2
Wah Weap	1977	56	...	2
	1978	38	...	0
Page Airport	1973	...	49	10
	1974	...	132	24
	1975	...	27	13
	1976	...	24	12
Page Water Tower	1975	...	31	5
	1976	...	33	9
	[a]1977	...	15	6
	1978	...	12	3
	1979	...	16	5

[a]Monitor operated by SRP moved from airport to city water tower on 10 February 1977.

TABLE A-9

Maximum Hourly Oxidant Concentrations

Site	Period of Observation	Maximum Hourly Average (μg/m³)
Page Water Tower	1974	96
	1975	80
	1976	63
	[a]1977	55
	1978	91
	1979	52
Fremont River	1974 - 1976 (3 seasons)	131

[a]Monitor operated by SRP moved form airport to city water tower on 10 February 1977.

TABLE A-10

Ambient Lead Particulate Concentrations Page, Arizona (Airport Site)

Year	Calendar Quarter Average Maximum (μg/m³)	Second Maximum (μg/m³)	Annual Average (μg/m³)
1973	...	...	0.1
1974	0.3	...	0.2
1975	0.4	...	0.1
1976	...	...	...
1977	...	...	...
1978	0.07	0.05	[a]0.06
1979	0.09	0.07	...

[a]Incomplete data.

APPENDIX B

METHODOLOGY FOR AIR QUALITY - VISIBILITY IMPACT ANALYSIS

Before assessment of the potential air quality and visibility impacts from coal development in southern Utah, it was necessary to make projections of the emissions as a function of location and time for each scenario, to assess the effects of worst-case and average meteorology, and to compare the calculated parameters with sampled data representing the current conditions. This section describes the methodology used to make such an assessment.

Six broad sources of data were available for the analysis. They included:

- The existing air quality data. These consisted of sampled concentrations for particulates and gaseous pollutants monitored in the study area in the past years.

- The existing meteorological data. These consisted of wind, temperature, precipitation, cloud cover, and atmospheric stability information from airports and climatic stations in the study area, as well as results from special, temporary, measurement programs.

- The existing visibility data. These consisted of visual range, color, and contrast values obtained by instruments and photographs on a number of lines of sight from viewpoints in the national parks, as well as statistical data on airport visual range made by human observers.

- The existing emissions inventory. These data consisted of county totals of emissions by pollutant, and considered such things as industrial sources and power plants, vehicle emissions, population, and rural and urban emissions such as agricultural and road dust and furnace emissions.

- The scenario assumptions. These provided guidance on mine locations and sizes, projected population growth, transport assumptions, mining methods, and relative schedules.

- Emission factors. These are estimates of pollution emitted for processes and individual machines based on measurements and best engineering practice. Engine exhaust pollutants per horsepower-hour and shovel dust per ton are examples.

Three separate types of analysis were required. These included:

- The local air quality impact. This was necessary because dust, for instance, settles out fairly rapidly and calculations at the mine boundary would not be applicable in the same plume winds downwind. Additionally, the rough terrain of the area makes it difficult to generalize calculations made in one area to another.

- The regional air quality impact. This analysis pertains to the stable gases and very fine particulates which, although perhaps meeting air quality standards, would nevertheless degrade the visibility on long, regional vistas and would allow one to assess the cumulative impacts of the individually varying, spatially distributed sources.

- The visibility impact analysis. This would use the results of the regional air quality analysis as input, and calculate such things as the visibility and color degradation due to various pollutants, differences by time of day along a given vista, and impact by scenario.

Each analysis utilized common portions of the available data and mutually complemented one another, but used different tools.

The local modeling used a simple gaussian sector average plume model, ERTAQ, to calculate concentration fields for annual average and worst-case hour conditions at 25 separate locations in the study area. Normalized source terms were used in the model with climatic annual average stability and wind data specific to the geography, and with worst-case hour meteorology peculiar to that site. In the transportation corridor assessment, normalized source terms for each pollutant were scaled by tons of coal hauled, and the scenario assumptions were used to assign true values to the isopleths once a scenario and time were chosen. In the coal lease areas, normalized source terms were based on high scenario mining activities and

production capacity for each pollutant, and were scaled as necessary to accommodate other scenario production levels. In the urban areas, emissions were normalized based on population, thus allowing the application of the results to other city sizes for other scenarios or years.

The regional modeling used a mesoscale gaussian puff dispersion model, MESOPUFF, in combination with a sequential hourly wind-field generating model, WINDY, which incorporated terrain. The entire regional study area including all mine, transport, and urban sources, were simultaneously evaluated for a worst-case year (based on total regional emissions) for each scenario. A three-day period in spring, summer, and fall was evaluated, using worst-case seasonal meteorology chosen by correlating actual sampled TSP maximums with sequential hourly and synoptic weather data. Four pollutants were individually evaluated for each case. These included five particulates (RSP), NO_x, SO_2, and SO_4. The source terms used in the model were individually sized to correspond with the city sizes, rail traffic, mine production levels, and commuting traffic applicable for each chosen scenario and year.

The visibility modeling used a visual range and discoloration model, VIRAD, which incorporated calculations for molecular and particulate scattering, absorbtion by particles and gases, and effects of sun, plume and observer geometry. Concentrations along predetermined lines of sight were taken from the regional air quality modeling results and used as input to the visibility model.

Once the results were available from local and regional air quality and visibility modeling, the projected concentrations were compared with applicable standards and existing sampled data to determine projected impacts.

A flow chart depicting the air quality-visibility analysis is presented in Figure 1.

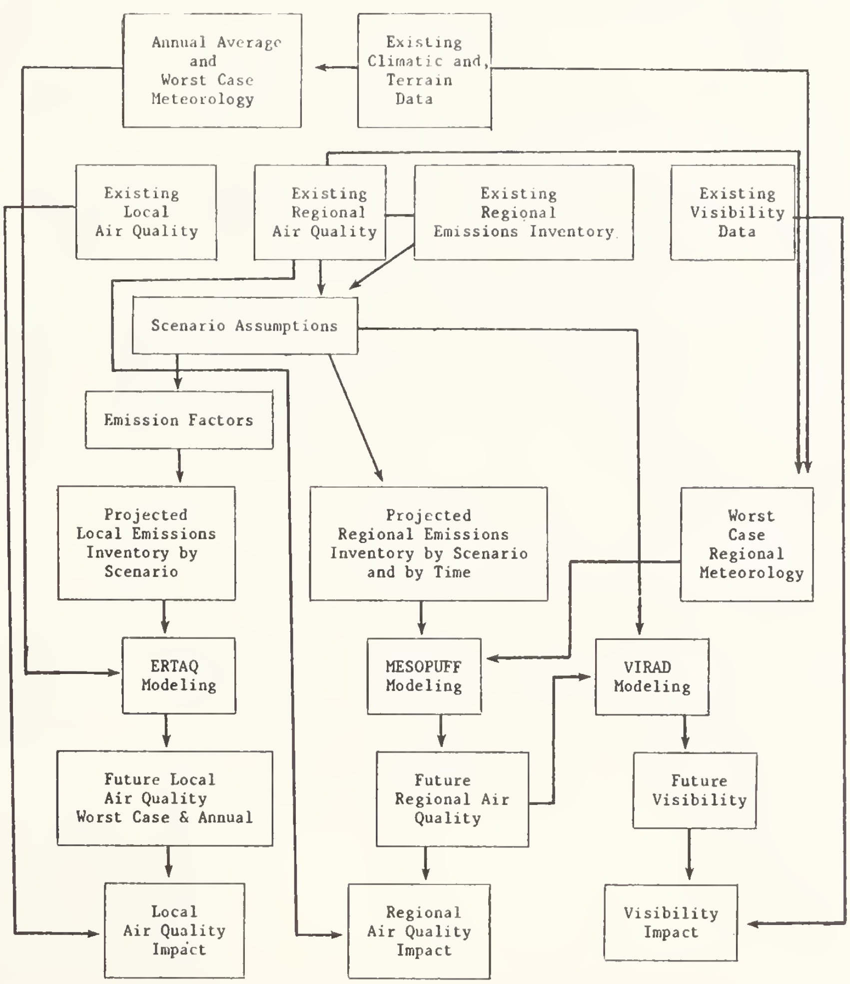


Figure 1. Methodology Used in Air Quality and Visibility Impact Analysis.

Figure B-2. Low Production Level - Percentage of Time That Given Visual Range is Exceeded. (Fair Summer Days Only)

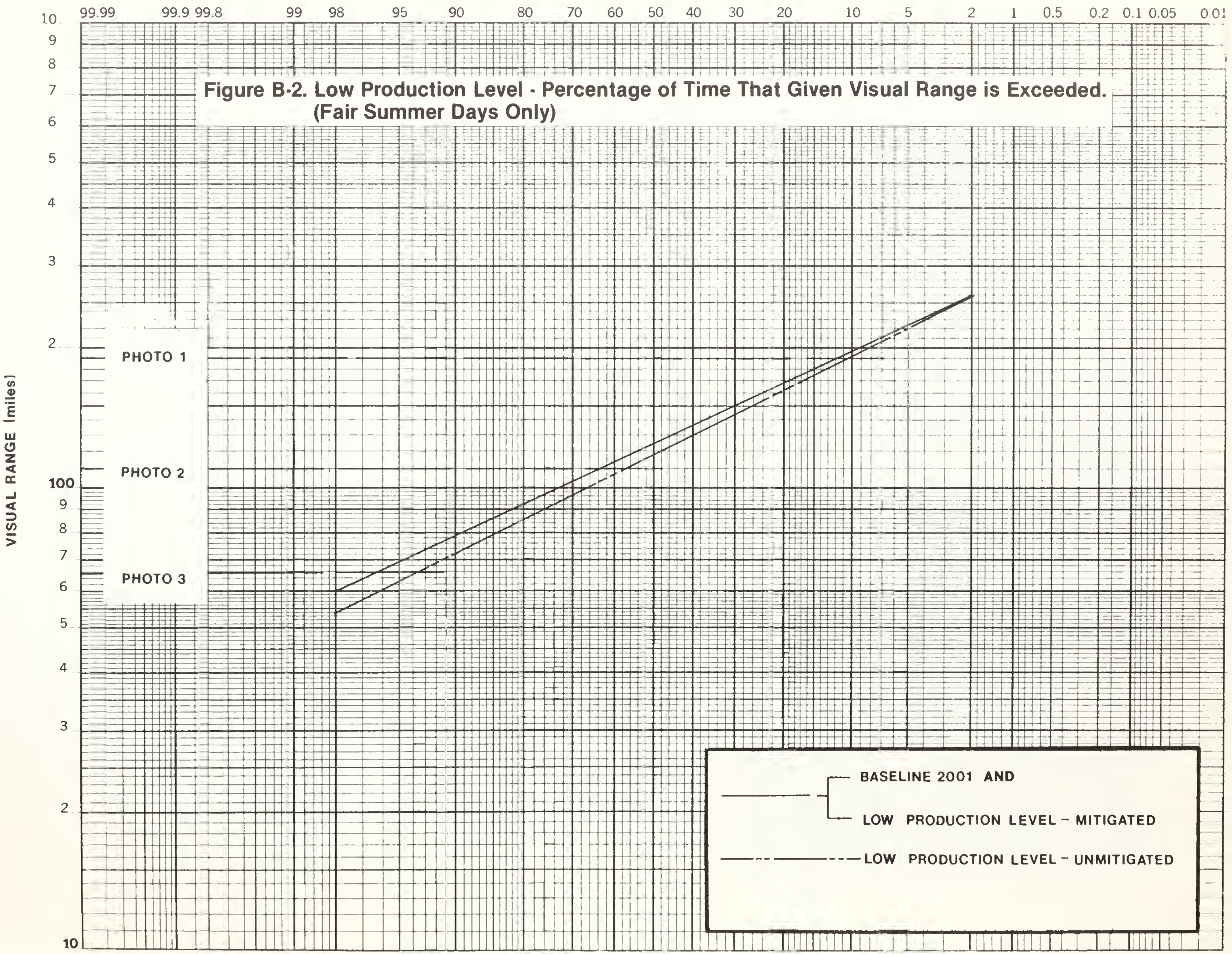


Figure B-3. Medium Production Level - Percentage of Time That Given Visual Range Is Exceeded (Fair Summar Days Only)

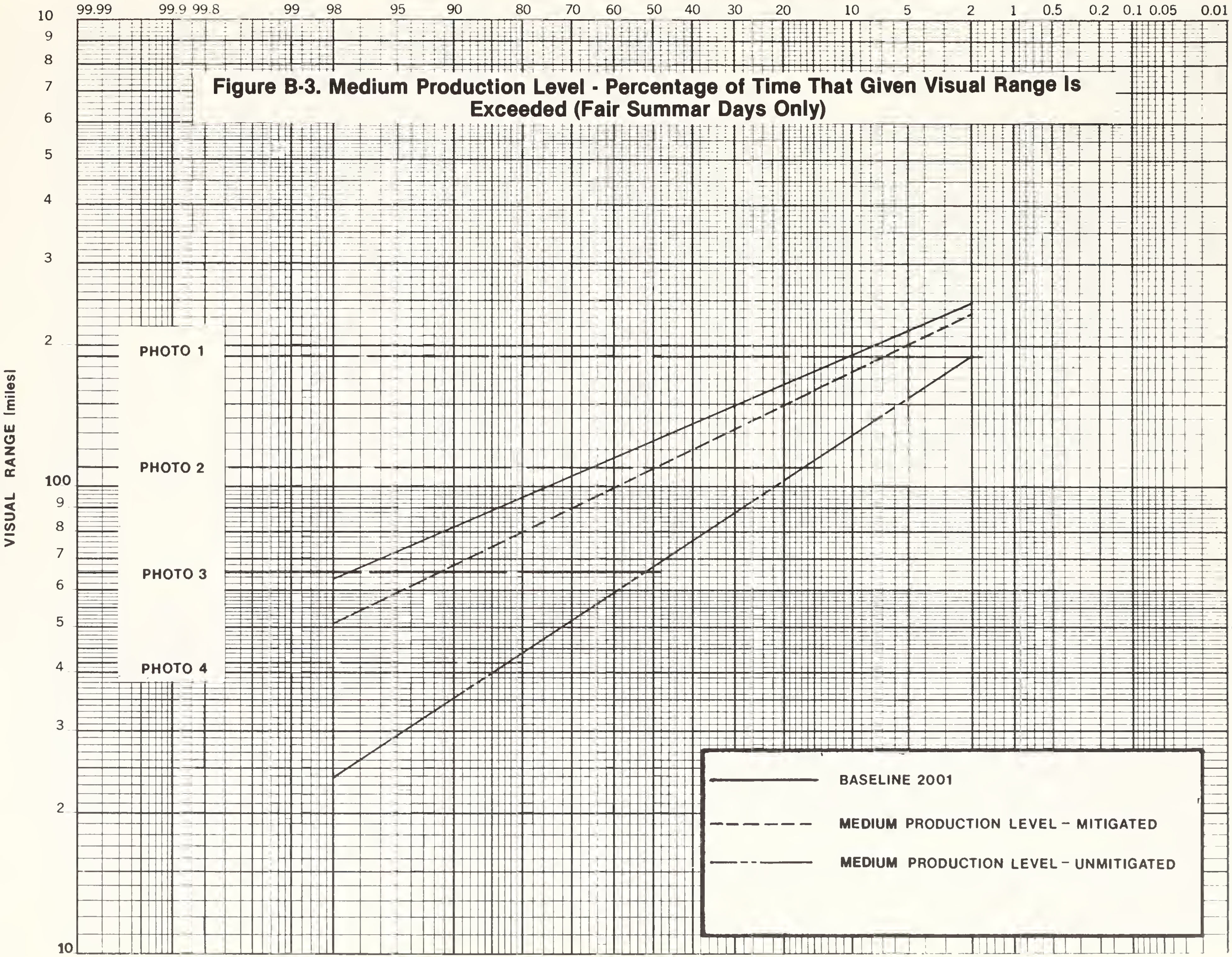
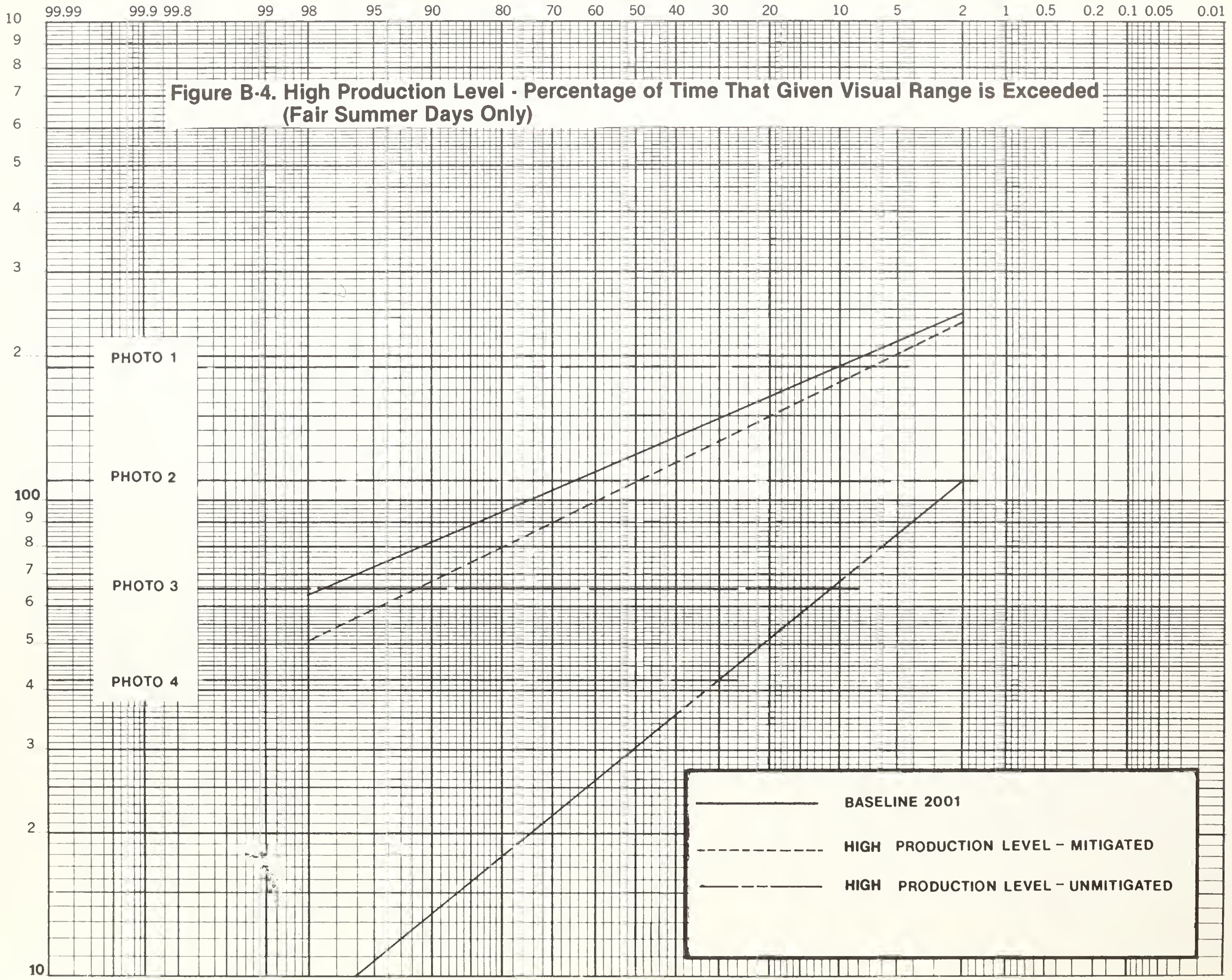


Figure B-4. High Production Level - Percentage of Time That Given Visual Range is Exceeded (Fair Summer Days Only)



APPENDIX C

VEGETATION DATA

TABLE C-1

UTAH PLANT SPECIES TO BE RECOMMENDED AS CANDIDATE SPECIES FOR LISTING IN THE 1980 NOTICE OF REVIEW

Species	Classification As of December 1979	Counties in which Species is known to Occur	Habitat Description
Astragalus barnebyi	T[1]	Garfield	Pinyon-juniper and mixed desert shrublands or mixed grass shrub-community; 4,300-6,000 feet; platy shales and silty sands (Carmel, Mancos Shale, Navajo Sandstone, Emery Member of the Mancos Shale).
Astragalus lentiginosus var.*ursinus*	E(W)[2]	Iron	Sagebrush or pinyon-juniper; 7,200 feet
Astragalus limnocharis	T(W)[3]	Iron, Kane	Lakeside beach herbaceous type; 8,800-10,500 feet; calcareous gravels of limestone breaks and beaches (Pink Limestone Member of the Wasatch Formation)
Astragalus striatiflorus	T[1]	Kane, Washington, Coconino	Anemophilous plant communities; 1,500-6,250 feet; sand dunes, sandy escarpments, sandy terraces (Quaternary dunes derived from Entrada and Navajo Sandstone Formations).
Castilleja aquariensis	E[4]	Garfield	Sagebrush and grass meadow community; 9,800 feet; clay-loam soil (Quaternary alluvium).
Castilleja parvula	T[1]	Piute, Beaver	Alpine vegetation, grassy meadow; 10,000-11,800 feet; igneous gravels and outcrops (Tertiary igneous gravels and outcrops).
Castilleja revealii	E[4]	Garfield	Ponderosa pine community; 7,800-8,000 feet; limestone, gravelly soil (Pink Limestone Member of the Wasatch Formation, Tertiary)
Cryptantha ochroleuca	E[4]	Garfield	*Pinus longaeva* and ponderosa pine community; 6,500-7,000 feet; angular limestone gravel (Pink Member of the Wasatch Formation).
Cymopterus higginsii	T[3]	Kane	*Atriplex-Kochia-Artemisia* community; 4,200-4,500 feet; Tropic shale and pedimental covering derived from Straight Cliffs and other formations, on saline soil (Tropic Shale Formation).

Cymopterus minimus	E[4]	Garfield, Iron	Mixed ponderosa pine, western bristle cone pine, Rocky Mountain juniper, Utah juniper community; 8,000–10,000 feet; white or red calcareous gravel (Pink or White Limestone Members of the Wasatch Formation).
Draba asprella var. *zionensis*	T[1]	Washington	Ponderosa pine-manzanita communities, less commonly in warm desert shrub communities; 5,000–5,500 feet; decomposed sandstone and talus (Mainly on Navajo Sandstone)
Draba sobolifera	T[1]	Garfield, Piute, Beaver	Spruce-fir and alpine communities; 7,500–12,000 feet; igneous gravel and humus over igneous gravel (Tertiary volcanics).
Epilobium nevadense	T[1]	Washington	Mixed pinyon-juniper-live oak; 7,770 feet; rocky slope (carboniferous limestones and dolomite).
Erigeron proselyticus	E(R)[5]	Iron	Spruce-fir community; 9,000 feet; limestone cliff faces and lime stone gravel (Wasatch Limestone Formation).
Erigeron religiosus	E[4]	Kane, Washington	Anemophilous plant communities in pinyon-juniper and ponderosa pine; 5,000–6,000 feet; sand (Quaternary sand dunes and *in situ* sand on Navajo sandstone).
Erigeron sionis	E[4]	Washington	Unknown
Eriogonum aretoides	E[4]	Garfield	Pinyon-juniper-ponderosa pine-western bristlecone pine community; 7,500-8,000 feet; calcareous gravel ridges on thin rocky soil (Pink Limestone Member of the Wasatch Formation).
Eriogonum corymbosum var. *matthewsae*	E(W)[2]	Washington	Salt desert shrub community; 4,000 feet; clay and clay-silt or mudstone (Chinle Formation).
Eriogonum cronquistii	E[4]	Garfield	*Pinyon-juniper-Holodiscus* community; 8,300–9,250 feet; decomposed granitic gravels (Tertiary igenous intrusives).
Eriogonum jamesii var. *rupicola*	T[1]	Kane, Washington	Pinyon-juniper community; 5,200-5,800 feet; crevices in sandstone and in sand (Navajo sandstone and Quaternary sand).

TABLE C-1 (CONTINUED)

Species	Classification As of December 1979	Counties in which Species is known to Occur	Habitat Description
Eriogonum panguicense var. *alpestre*	T[1]	Iron	Meadows in spruce-fir community; 10,000-11,000 feet; clayey soil (Wasatch Limestone Formation and Tertiary igneous outcrops).
Eriogonum zionis var. *zionis*	E[4]	Kane, Washington, Coconino	Pinyon-juniper, ponderosa pine, and sagebrush communities; 4,800-6,000 feet; sandy soil (Navajo Sandstone Formation).
Lesquerella rubicundula	T[1]		Spruce-fir-aspen-community; 8,000-10,000 feet; clayey or gravelly loam (White and Pink Limestone).
Lesquerella tumulosa	E[4]	Kane	(Member of Wasatch Formation). Blue grama grassland, in scattered juniper; 5,700-5,800 feet; calcareous mudstone (Winsor Member of Carmel Formation).
Lomatium minimum	E[4]	Garfield, Iron, Kane	Spruce-fir and meadow community and in ponderosa pine-pygmy sagebrush communities; 7,800-10,400 feet; calcareous gravels and clays, White and Pink Limestone (Wasatch Formation).
Penstemon atwoodii	T(W)[3]	Garfield, Kane	Pinyon-juniper woodland and ponderosa pine woods; 6,200-8,000 feet; grayish sand and clay loam (Kaiparowits, Wahweap, Straight Cliff Formations).
Penstemon bracteatus	T(W)[3]		Ponderosa pine and pinyon-juniper communities; 7,800-8,000 feet; calcareous gravel (Pink Limestone Member of Wasatch Formation).
Penstemon concinnus	E(R)[5]	Iron	Pinyon-juniper, sagebrush, and mixed desert shrub communities; 6,300-7,500 feet; calcareous gravelly pediments (Sevy Dolomite Formation and alluvium derived from that formation).
Penstemon humilis var. *obtusifolius*	T(W)[3]	Washington	Ponderosa pine, oak, serviceberry, and juniper communities; 5,000-7,300 feet; sandy soils (Navajo Sandstone Formation).
Penstemon parvus	T[1]	Garfield, Piute, Wayne	Grass-sagebrush community; 8,200-11,500 feet; sandy gravelly loam (Tertiary volanic gravels).

Phacelia anelsonii	T[1]	Washington	Joshua tree-cresote community; 2,500-4,000 feet; variable, limestone outcrops and gravel to silts, sands, and clays (Carboniferous limestones and dolomites; Tertiary and Quaternary alluvium).
Phacelia howelliana	T[1]	Grand, San Juan	Pinyon-juniper and desert shrub communities; 3,700-5,200 feet; red, silty sands, gravelly or sandy-clay soils (Moenkopi, Cutler, Kayenta, and possibly other formations).
Phacelia mammillarensis	E[4]	Kane, Garfield	Pinyon-juniper and salt desert shrub communities; 4,000-6,000 feet; clay or sandy saline soils (Tropic Shale, Kaiparowits, Dakota, Morrison, and Entrada Formations).
Psoralea epipsila	E[4]	Kane, Coconino	Pinyon-juniper woodland; 5,000-5,400 feet; gypsiferous clay soil (Chinle and Moenlcopi Formations).
Psoralea pariensis	T(W)[3]	Kane, Garfield	Ponderosa pine and juniper-pinyon woodlands; 5,500-8,000 feet; calcareous or sandy soils (Pink Limestone Member of Wasatch Formation, Navajo Sandstone, Quaternary alluvium).
Ranunculus acriformis var. *aestivalis*	Ex[6]	Garfield	Moist meadow community; 6,000 feet; wet meadow land, boggy soil (Quaternary alluvium, along a seep line).
Silene petersonii var.*minor*	T(W)[3]	Garfield, Iron	Ponderosa pine-Rocky Mountain juniper, spruce-fir, and aspen-sagebrush communities; 7,000-10,450 feet; calcareous and igneous gravels (Pink Limestone Member of Wasatch Formation, Tertiary igneous gravels).
Spaeromeria ruthiae	E(W)[2]	Washington	Mixed ponderosa pine-mountain brush community; crevices in sandstone (Navajo Sandstone Formation).
Viola purpurea var. *charlestonensis*	T[1]	Washington	Ponderosa pine community; 6,850 feet; sandy duff on forest floor (Navajo Sandstone Formation).

[1]T- Reviewed as threatened, Federal Register, July 1, 1975.

[2]E(W) - Presently has no legal status, recommended as endangered by S. L. Welsh, 1978.

[3]T(W) - Presently has no legal status, recommended as threatened by S. L. Welsh, 1978.

[4]E -Proposed as endangered by Federal Register, June 16, 1976.

[5]E(R) - Reviewed as endangered, by Federal Register, June 16, 1976.

[6]Ex - Reviewed as probably extinct, Federal Register, July 1, 1975.

TABLE C-2

ARIZONA SPECIES LISTED AS THREATENED OR ENDANGERED AND SPECIES TO BE RECOMMENDED AS CANDIDATES FOR LISTING IN THE 1980 NOTICE OF REVIEW

Species	Classification As of December 1979	Counties in which Species is known to Occur	Habitat Description
Pediocactus sileri	E[1]	Coconino	Gray gypsum hills derived from the Moenkopi formation
Pediocactus peeblesionus	E[2]	Coconino	Pockets of limestone chips derived from Kaibalb limestone, in localized desert pavement-like flat areas adjacent to breaks
Eviogonum mortonianum	E[2]	Coconino	Gypseous soil on red clay hills derived from the Moenkopi formation
Eriogonum thompsonae var. *atwoodii*	E[2]	Coconino	Same as *E. mortonianum* above

[1]Protected as endangered (Federal Register 44(209): 61788. October 26, 1979.

[2]Will be Recommended as Endangered by A. Phillips, Museum of Northern Arizona, to the USFWS during 1980.

APPENDIX D

TABLE D-1

PALEONTOLOGICAL SUMMARY FOR GEOLOGIC FORMATIONS

FORMATION	DESCRIPTION
Moenkopi	The Moenkopi Formation is of both continental and marine origin, and has yielded a highly significant assemblage of fossils. Vertebrate fossils have been discovered, including reptiles, amphibians, and fishes (McKee 1954; Welles 1947). Also recovered are invertebrate fossils (McKee 1954), plant fossils (McKee 1954), and trace fossils (McKee 1954; Peabody 1948).
Chinle	The Chinle Formation is of predominantly continental origin and has yielded a diverse assemblage of vertebrate fossils including reptiles, amphibians, and fishes (Colbert 1972, 1974; Jacobs and Murry 1980). Also present are invertebrate fossils (Breed 1972; Stewart et al., 1972) and plant fossils (Ash 1975; Gottesfeld 1972; Stewart et al., 1972).
Kayenta	The Kayenta Formation is of continental origin and published accounts of its fossils describe vertebrates including two kinds of reptiles (Lewis 1954, 1958; Welles 1954) and trace fossils (Welles 1971). Recent unpublished work by Timothy Rowe done in collaboration with the Museum of Comparative Zoology, Harvard University, has found an extensive diverse assemblage of vertebrate fossils, trace fossils, and plant fossils in the Kayenta Formation which greatly increase the numbers and significance of fossils known from this formation.
Kaiparowits	A number of vertebrate fossils have been recovered from the Kaiparowits Formation (DeCouten 1978; Marshall and Breed 1974) together with invertebrates (DeCouten 1978), trace fossils, and plant fossils (Doelling 1977; Lohrengel 1969).
Wasatch	The stratigraphy of the Wasatch Group in the study area is poorly understood and forms the subject of a considerable controversy (e.g., Donnell et al., 1953; Gazin 1941; Williams 1950). It is generally agreed that rocks assigned to this group are predominantly continental in origin and of Early Tertiary age. Equivalent beds have yielded an extensive fauna of Early Tertiary vertebrates (Gazin 1941) which may be expected to occur in the study area.
Kaibab	The Kaibab Limestone is of marine origin and has yielded abundant, diverse assemblages of invertebrate fossils together with rare vertebrate fossils (McKee 1934; McKee and Breed 1969; Mather 1970). McKee (1934) has reported a number of localities from the general vicinity of the study area.
Moenave	The Moenave Formation is of continental origin and has yielded well-preserved, highly significant vertebrate fossils (Colbert 1974) and trace fossils (Davis 1977).
Navajo Sandstone	The Navajo Sandstone is of continental origin and has yielded significant vertebrate fossils (Brady 1935, 1936; Camp 1936; Galton 1971) together with abundant trace fossils (Harshbarger et al., 1957; Picard 1977).
Carmel	The Carmel Formation is of marine origin and has yielded abundant diverse invertebrate fauna (Baker et al., 1936, 1947; Gilluly and Reeside 1927; Imlay 1964; Sohl 1965). These fossils have received considerable attention and have proved to be highly significant.
Winsor	The Winsor Formation has received almost no paleontological attention, and there are no published reports of fossils from it. However, a brief reconnaissance survey of parts of the Winsor Formation in August 1979 indicated that its exposures are excellent and do contain fossil wood. Its lithology indicates that the Winsor Formation is predominantly continental in origin, and it possesses a high potential for preservation of excellent Lower Jurassic age vertebrate fossils. Terrestrial vertebrates from the time interval represented by the Winsor Formation are rare throughout the world, and any discoveries made in the Winsor will be of great significance.

TABLE D-1 (CONTINUED)

FORMATION	DESCRIPTION
Tropic Shale	The Tropic Shale is of marine origin and has yielded abundant diverse assemblages of invertebrate fossils (Gregory 1931, 1950). No vertebrates have been reported, but their presence may be expected, as indicated by their presence in ecologically and temporally equivalent strata from elsewhere on the Colorado Plateau.
Curtis	The Curtis Formation is predominantly of marine origin, and has yielded a limited, but significant fauna of marine invertebrate fossils (Gregory 1950).
Dakota Sandstone	The Dakota Sandstone is of both continental and marine origin, and has yielded rare, poorly preserved vertebrate fossils and numerous plant and trace fossils (May and Traverse 1973; Moir 1974; Waage 1959).
Wahweap Formation	The Wahweap Formation is of both marine and continental origin. It has yielded rare, poorly preserved fossil vertebrates, and abundant invertebrate and plant remains (Gregory 1950).
Straight Cliffs Sandstone	The Straight Cliffs Sandstone is also of both marine and continental origin, and has yielded rare, poorly preserved vertebrates and numerous invertebrate fossils (Gregory 1950).
Sevier River Formation	No fossils have been reported from the Sevier River Formation, but this may be entirely a result of inadequate study. The lithology and age of this formation indicate that fossil vertebrates are likely to be encountered.
Entrada Sandstone	The Entrada Sandstone was judged to be of minimum paleontological sensitivity.

Source: ERT Project Team

APPENDIX E

NATIVE AMERICAN CONCERNS

Methodology

As potentially impacted cultural and historic resources within the Kaiparowits region, Native American sacred areas should be studied according to the Congressional Declaration of National Environmental Policy (83 Stat. 852). The Historic Preservation Act (80 Stat. 915) supports the need to study Indian cultural resources when it encourages the "historic preservation" of objects significant in American history including archaeology sites and culturally important locations. Finally, the American Indian Religious Freedom Act of 1978 (92 Stat. 469) supports the above positions given the special status of Native American people in the United States. This law guarantees American Indians access to sacred sites required in their religion, including cemeteries, and the freedom to use sacred natural species and resources in the practice of their religion, even though these resources may no longer be controlled by the Indian people.

In addition to defining what will be studied, recent Federal laws define the legal rights of Native American people to participate in the process. The final regulations of the National Environmental Policy Act that appeared on November 29, 1978, in the Federal Register (Vol. 43 #230:44978-56007) clarify the appropriate role of Indian Tribes as participants in the N.E.P.A. process. According to this section (55989) Indian Tribes should have early knowledge of projects, are invited to participate in the formulation of issues and the research itself, and are invited to comment on draft reports prior to finalization. They have these rights whenever a project can impact Indian people living on a reservation.

It is necessary to discuss in detail the legal status of Native Americans and their resources because the laws are new and, therefore, still open to different interpretations that can clearly influence the methods, topics, depth, and, eventually, implications of research such as this. Some of the major issues are: (1) Which Native American cultural groups are potentially impacted and therefore have the right to make comments about the resources of a particular study area? (2) What are sacred cultural sites and resources? (3) What is an appropriate or representative response from a Native American group? and (4) What is valid evidence and how much weight should it be given by compilers and reviewers of reports?

Potentially Impacted Groups

In order to determine which Native American groups are potentially impacted and have the right to make comments about the resources of a particular study area, the criteria for being a "Native American group" and being an "occupant" of the study area have to be established.

While much of the legislation regarding Native American resources has used the term "tribe," clearly it is being used in a broader sense than the definition used by the anthropology profession. A key issue, were the latter more restricted use of the term to be used, is whether or not an Indian group is sovereign over its people, resources, and territory. Because such a definition would exclude many Native American peoples from having the right to make responses and because previous impact statements have taken the broader definition of tribe (Bean and Vane 1978, 1979), this report interprets the term "tribe" to mean a Native American cultural (ethnic) group as this concept is generally used by professional anthropologists. Such a definition permits inclusion of linguistically, culturally, and socially distinct Indian groups, even though they may no longer own their traditional lands or may not be recognized by the Bureau of Indian Affairs (BIA) as an "organized tribe." This is a critical broadening of the definition for the Kaiparowits Regional Planning Study because all Paiute groups in the State of Utah gave up their reservation status a generation ago, while other Paiute groups have been incorporated as cultural minorities on the Navajo Indian Reservation.

A second criteria for establishing which groups are potentially impacted is that of a group having occupied portions of the study area. Here we find two ways of making such a determination, both of which are accepted as valid in this study. The most common definition of "occupancy" refers to a Native American group who occupied portions of the study area on a full-time basis at the time of Euroamerican contact. The terms "aboriginal inhabitant" and "traditional territory" usually refer to such a group and their land. A second definition of "occupant" is a Native American group who currently lives in the study area on a year-round basis. Each definition assumes that residency in the study area was sufficient

for the Native American group to incorporate features of the area into its definition of cultural-self.

Using these criteria this study has defined seven Native American groups as having sacred cultural resources in the study area that could be potentially impacted by the Kaiparowits Region coal development.

Sacred Sites and Resources

Any impact assessment report must come to grips with a definition of what are Native American sacred cultural resources and how are they to be determined. Since the passage of the American Indian Religious Freedom Act there has been a major attempt to specify how this law is to be translated into specific United States government agency regulations. A Federal Agencies Task Force (1979), in consultation with Native American traditional religious leaders, has just released a report that summarizes the thoughts of numerous interests groups regarding what Native American sacred cultural resources are and how they should be protected. Already this report has stimulated great controversy (White 1980) and recent articles in the *American Anthropologist* (Rosen 1980) and *American Antiquity* (Winter 1980) suggest that the argument will continue.

For the present research an attempt has been made to find a middle ground in the definition of these resources that will be acceptable to most of the interest groups who have expressed their opinion on this critical issue. The following research assumptions have been established by ethnographic and ethnological analysis of religion and are generally acceptable to professional anthropologists. The assumptions, also, have been accepted in previous impact assessment studies (Bean and Vane 1978, 1979) by some Native American groups, and some Federal agencies and major corporations. This study assumes that human groups vary in the degree to which they define portions of their society, culture, and material resources as sacred rather than secular. It is also assumed that when compared with many other ethnic groups in contemporary United States society, Native Americans generally define more of their social, cultural, and material resources as sacred. It is assumed that among sacred resources or socio-cultural patterns some can be more important than others and that this relative importance can be changed over time by group consensus. Inasmuch as the sacredness of these resources can and does change through time it is assumed by this research that no assessment of Native American sacred resources is complete without consulting with the potentially impacted group. Therefore, a Native American group can define as sacred a wide range of resources from food, to the places they once lived, to activities they do, and to their ancestors' burials; and only they can make such a determination.

These research assumptions help place in perspective apparently conflicting responses regarding potential impacts on sacred resources. For example, a Native American person can say, without the statements being in mutual conflict, that all of the land is sacred and later that a specific area is clear of sacred resources and would not be harmed by construction. In the first case, the response is to the general idea of having the development occur at all, while the latter is a conditional response which means that if the project goes ahead, then the area has the fewest cultural resources.

Native American Representatives

Another basic question that must be answered in an impact report such as this one is what is an appropriate or representative response from a Native American group? When a group is organized and recognized by the BIA, the first level of contact is the tribal chairman and council. This situation pertains to the Kaibab Paiute Tribe and the Navajo Nation. Depending on the size of the tribe and the degree of concern over the proposed development, the council will either make the statement directly or specify an appropriate person or committee to make the response. A much more complex situation exists when the Native American group is not officially recognized and may therefore not have a spokesperson in a position to speak for the group. Although all of the Paiute groups in the state of Utah have lost their reservation status, many are in the process of again receiving BIA recognition. As of the writing of this report, the five Southern Paiute groups (Koosharem, Kanosh, Cedar City, Indian Peaks, and Shivwits) were organized as a whole group (tribe) and also as individual local groups (bands). As such they have sought official BIA status and received the approval of House of Representatives on February 25, 1980. The least organized and recognized Native American groups in the study are the so-called "San Juan Paiutes," who are currently represented by the Willow Springs and Navajo Mountain groups. An undetermined

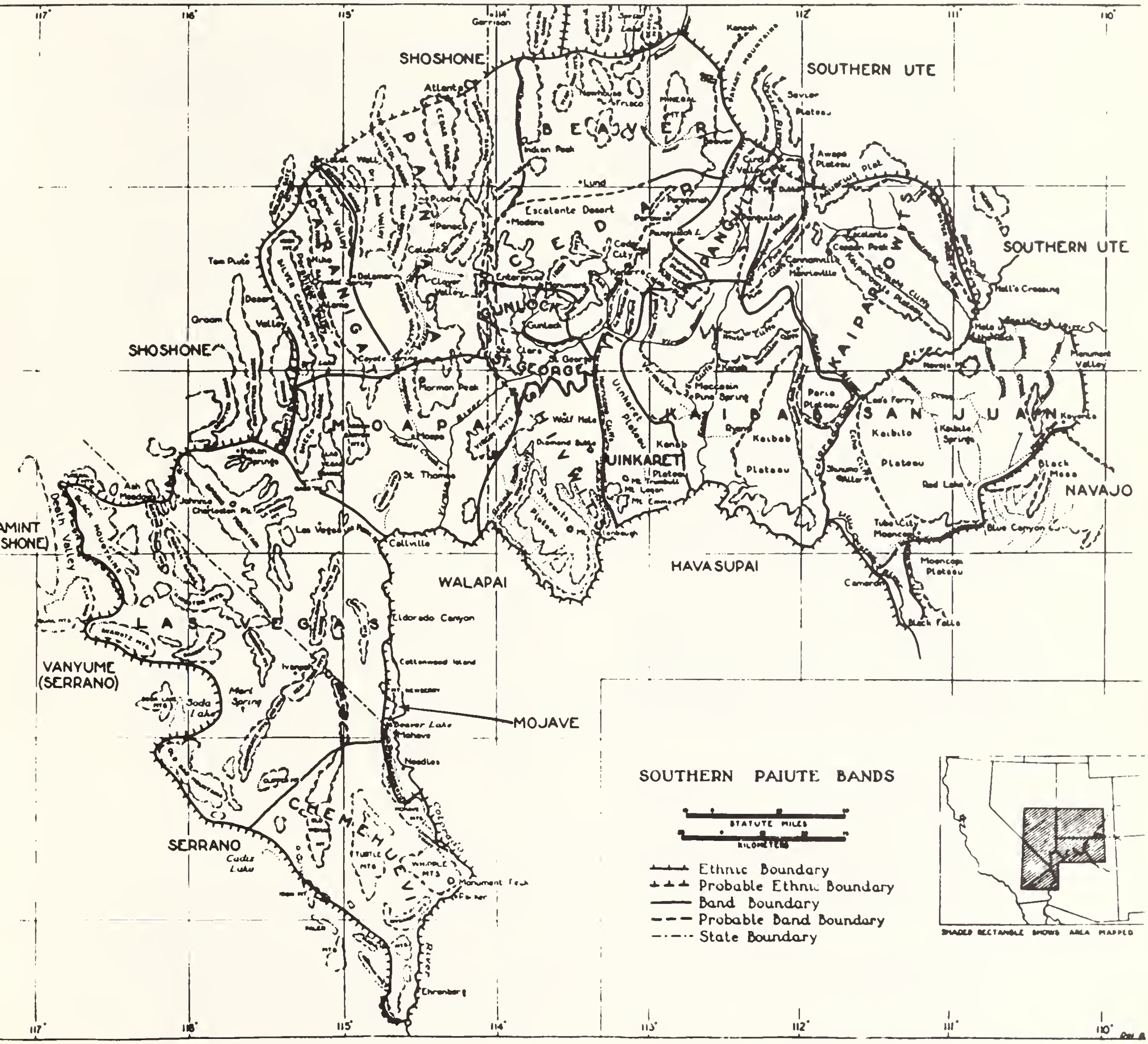
number of these people (perhaps 300) define themselves as Southern Paiute, continue to speak the Paiute language, follow many traditional Paiute cultural ways, and live on lands that are officially designated as a portion of the Navajo Reservation. While these people are territorially and politically incorporated by the Navajo Nation, they have expressed the desire to be considered as a separate and culturally distinct group. Their spokesperson's status is based on informal group consensus.

In addition to establishing the appropriate contact person for a Native American group, there still remains the question of how to elicit the most complete and most representative response to the potential development project. This is an issue that must be carefully negotiated with the group's contact person, who must understand the project and the type of impact study being conducted. There are three broad types of Native American expert consultants and each will probably provide a different perspective on sacred resources. These types of consultants are: (1) traditional religious practitioners, (2) members selected at random from the group's membership, and (3) persons who have the most direct contact with the potentially impacted portions of the study area. Tradition religious practitioners have specialized knowledge of religious practice, religious materials, and religious locales that many persons in the group will not have. A random selection of group members, usually divided by age, sex, and whether residing on or off the reservation, will help specify the range of knowledge and the diversity of concerns for sacred resources. Finally, consulting with persons who actually live within the study area or have lived there in recent times often will provide the greatest detail regarding presence and distribution of sacred resources. This study has drawn upon the first and third types of consultants wherever study time and the appropriate persons were available.

Evidence Validity

The information contained within any impact report must be supported by as much evidence as is available. Inasmuch as a great majority of Native American sacred cultural resources are in lands they no longer own, it is often necessary to specify why a Native American person or group has the right to express concerns over the disposition of these resources. The major data sources for specifying the cultural concerns of Native American peoples are ethnohistorical. An ethnohistorical methodology involves using multiple data sources to "triangulate" (or know from 3 or more different perspectives) whether or not a point of information is correct. For any one point of information archaeological, document, and oral history data may be available. Ethnographic comparisons with living peoples or with contemporaries for whom more data are available serve to further validate the ethnohistorical findings.

Oral history is a corner stone of the ethnohistorical method. It generally is accepted as valid evidence by professional ethnohistorians who since the early 1930s have used such data as testimony in Indian Land Claims Commission legal court actions (Dobyns 1979) and in the reconstruction of historic events and cultural patterns of other New World ethnic groups such as Afro-Americans (Stoffle and Shimkin 1980). For this study area both Paiute and Navajo oral history accounts have been tested and supported by archaeological and document research.



Source: Kelley 1934

APPENDIX F

VISUAL QUALITY RATINGS

BLM Visual Resource Management Classes

Class I. This class provides primarily for natural ecological changes; however, it does not preclude very limited management activity. Any contrast created within the characteristic environment must not attract attention. It is applied to wilderness areas, some natural areas, wild portions of the wild and scenic rivers, and other similar situations where management activities are to be restricted.

Class II. Changes in any of the basic elements (form, line, color, texture) caused by a management activity should not be evident in the characteristic landscape. A contrast may be seen but should not attract attention.

Class III. Contrasts to the basic elements (form, line, color, texture) caused by a management activity may be evident and begin to attract attention in the characteristics landscape. However, the changes should remain subordinate to the existing characteristic landscape.

Class IV. Contrasts may attract attention and be a dominant feature of the landscape in terms of scale; however, the change should repeat the basic elements (form, line, color, texture) inherent in the characteristic landscape.

Class V. Change is needed or change may add acceptable visual variety to an area. This class applies to areas where the naturalistic character has been disturbed to a point where rehabilitation is needed to bring it back into character with the surrounding landscape (BLM 1978).

USFS Visual Quality Objectives

P - Preservation. This visual quality objective allows ecological changes only. Management activities, except for very low visual-impact recreation facilities, are prohibited. This objective applies to Wilderness areas, primitive areas, other special classified areas, areas awaiting classification and some unique management units which do not justify special classification.

R - Retention. This visual quality objective provides for management activities which are not visually evident. Under retention activities may only repeat form, line, color, and texture which are frequently found in the characteristic landscape. Retention should be accomplished either during operation or immediately after.

PR - Partial Retention. Management activities remain visually subordinate to the characteristic landscape when managed according to the partial retention visual quality objective. Activities may also introduce form, line, color, or texture which are found infrequently or not at all in the characteristic landscape, but they should remain subordinate to the visual strength of the characteristic landscape. Reduction in form, line, color and texture contrast to meet partial retention should be accomplished as soon after project completion as possible or at a minimum within the first year.

M - Modification. Under the modification visual quality objective, management activities may visually dominate the original characteristics landscape. However, activities of vegetative and land form alteration must borrow from naturally established form, line, color, or texture so completely and at such a scale that its visual characteristics are those of natural occurrences with the surrounding area of character type. Reduction in form, line, color, and texture contrast should be accomplished in the first year or at a minimum should meet existing regional guidelines.

MM - Maximum Modification. Management activities of vegetative and landform alterations may dominate the characteristic landscape. However, when viewed as background, the visual characteristics must be those of natural occurrences within the surrounding area or character type. When viewed as foreground or middle ground, they may not appear to completely borrow from naturally established form, line, color, or texture. Alterations may also be out of scale or contain detail which is incongruent with natural occurrences as seen in foreground or middle ground. Reduction of contrast should be accomplished within five years (USFS 1974).

APPENDIX G

TRANSPORTATION DATA AND METHODOLOGY

Vehicle Delays

To evaluate the possible disruption associated with potential at-grade crossings, several factors were examined including number of interruptions per day, length of time required for the unit train to cross the road, and the average daily traffic for each road.[1] Using these factors, two comparative estimates were prepared one estimating the number of vehicles potentially delayed by a single crossing during the mine employee commuter peak hours, and a second estimating the total number of vehicles potentially delayed over a 24- hour period.

Key assumptions used in the analysis are as follows:

a) each unit train operates with an average of 82.6 100-ton cars and is 4,472 feet long,

b) train speeds are assumed to average 30 mph throughout the area, and

c) the trains are assumed to be spread equally throughout a 24-hour period, operating 260 days a year.

The first factor, the number of interruptions per day, differs at medium and high production levels. At the medium production level, the maximum number of trains would be along the Kaiparowits-to-Milford route because the rail operations could pick up North Kaiparowits and Alton coal in addition to South Kaiparowits coal. The maximum tonnage would be 54 MTY which equals 25 trainloads per day. On the routes to Salina, Cedar City, and Flagstaff, the maximum tonnage would be 45 MTY, or 21 trainloads per day. At high production, the maximum tonnage to Milford would be 45 MTY, or 39 trainload per day, and to Salina, Cedar City, and Page, the maximum would be 75 MTY or 35 trainloads per day. In addition to these loaded trains, there are an equal number of unloaded trains making the return trip back to the mine. Each of these trains are assumed to cross each road independently of the other trains. Therefore, the number of interruptions on each road equals the number of train crossings in both directions. This is summarized in Table G-4.

[1]Procedure used adopted from Iowa Department of Transportation's *Vehicle Delay Times At Railroad Crossings*, September 1977.

TABLE G-1

MONTHLY VARIATIONS IN TRAFFIC DEMAND

Automatic Traffic Recorder Count Station	Percent Month Daily Average is of Year Daily Average											
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
U.S. 89 - East of Kanab	66.1	61.3	86.6	99.4	122.2	145.9	156.7	154.1	136.0	71.8	56.6	43.5
U.S. 89A - South of Kanab	74.4	74.2	82.9	91.1	109.8	135.2	135.8	129.5	110.0	94.6	85.0	77.5
U.S. 89 - North of Marysvale	51.6	57.2	77.8	85.8	107.7	139.0	158.9	152.6	119.9	106.3	77.8	65.3
I-15 - North of U-9	72.7	76.3	89.6	88.6	92.7	130.1	142.0	137.8	109.9	97.1	82.6	80.5
U-14 - Junction of U.S. 89	21.7	21.9	37.0	49.7	109.2	168.1	216.4	192.6	163.0	119.9	55.0	44.6
U-9 - Harrisburg Junction	66.4	71.9	81.8	92.7	110.4	120.4	126.7	139.0	121.5	102.8	87.4	78.8

Source: *Traffic on Utah Highways, 1978,* U.D.O.T. Automatic Traffic Recorder Data Summaries

TABLE G-2

VEHICLE CLASSIFICATION SUMMARY

Route	Location	Utah Passenger Vehicles %	Out-of-State Passenger Vehicles %	Light[1] Trucks %	Heavy[2] Trucks %
U-9	Junction U.S. 89 - Mt. Carmel Junction	11.1	60.4	19.7	8.8
I-15	South of St. George	12.4	50.9	16.6	20.1
U.S. 89	Kanab City Limits	18.3	38.2	27.8	15.7
U.S. 89	Mr. Carmel Junction	19.7	42.7	24.9	12.7

Source: *Traffic on Utah Highways, 1978,* U.D.O.T. Manual Classification Summary

[1]Light trucks: pick-ups, vans, campers

[2]Heavy trucks: vehicles with more than four tires

TABLE G-3

BASELINE DEMAND - SERVICE VOLUME B RATIOS

		Condition 1 Average Annual Daily Traffic (A.A.D.T.)			Condition 2 Recreational Travel Peak Demand (July)		
Facility	Location	Peak Hour Estimates	Service Volume[1]	Volume/Capacity Ratio	Peak Hour Estimates	Volume[1]	Volume/Capacity Ratio
U.S. 89	Glen Canyon City	195	735	0.27	305	735	0.41
U.S. 89	East of Kanab	350	735	0.48	550	735	0.75
U.S. 89	Glendale	330	465	0.71	520	465	1.12
U.S. 89	U-12 Intersection	295	720	0.41	470	720	0.65
U-12	Cannonville	75	540	0.14	165	540	0.31
U-12	Escalante	100	500	0.20	215	500	0.43
U-9	Mt. Carmel Junction	140	335	0.42	305	335	0.91
U-14	Long Valley Junction	80	335	0.24	175	335	0.52

Source: ERT Project Team

[1]U.D.O.T. Assigned

TABLE G-4

NUMBER OF INTERRUPTIONS PER DAY AT EACH INTERSECTION

Destination	Medium Production		
	Maximum Tonnage	# Trainloads	# Interruptions
Salina	45	21	42
Milford	54	25	50
Cedar City	45	21	42
Page/Flagstaff	45	21	42
	High Production		
Salina	75	35	70
Milford	84	39	78
Cedar City	75	35	70
Page/Flagstaff	75	35	70

The second determinate factor, length of delay per train crossing, is a function of train length, the level of traffic on the highway facility crossed by the rail line, train operating speed, and type of rail crossing control. A basic assumption is that on roads with higher traffic demand, there would be a longer vehicle queuing at the crossing and it would take longer for the traffic to clear. For each signalized at-grade rail crossing, the highway would be blocked an average of 2.2 minutes. Non-signalized at-grade crossings would result in a highway blockage averaging 1.9 minutes in duration.

Vehicle/Train Collisions

The basis for this analysis is the U.S. Department of Transportation's model for predicting the number of accidents per year at rail crossings[1]. The variables involved in the hazard prediction formula include an "exposure index" that factors in both daily train traffic and average daily road traffic, the type of crossing control, the number of trains, the number of railroad tracks, the type of highway surface (paved or gravel), the local population, and the highway type.

The assumptions pertaining to the railroad route within the corridor are the same as used in the delay analysis. At-grade crossings are assumed at each roadway encountered in the transportation corridor, with the exception of Interstate 15, which is assumed to be grade-separated. All crossings are assumed to occur outside of any neaby urban or town centers. Also, the maximum tonnage is assumed for each route to show the worst-case conditions. The results are given in accidents per year in Table G-5 for medium production and Table G-6 for high production.

[1]Metzger, Peter. 1980. Rail-Highway Crossing Hazard Prediction Research Results. USDI.

TABLE G-5

GRADE-CROSSING HAZARD AT MEDIUM PRODUCTION LEVEL ACCIDENTS PER YEAR BY CLASS OF WARNING DEVICE[1]

Route	H_{1-4}	H_{5-7}	H_8
S. Kaiparowits to Page			
Rt 89g	0.970	0.290	0.100
S. Kaiparowits to Cedar City			
Rt 89g	0.970	0.290	0.100
Rt 61	0.604	0.182	0.061
Rt 59	0.563	0.169	0.056
Rt 9	0.743	0.223	0.074
Rt 17	0.668	0.201	0.067
3 dirt roads	0.252	0.076	0.025
S. Kaiparowits to Milford			
Rt 20	0.473	0.142	0.047
Rt 89c	0.970	0.290	0.088
Rt 21	0.563	0.169	0.056
6 dirt roads	0.650	0.151	0.050
S. Kaiparowits to Salina			
Rt 12	0.765	0.230	0.076
Rt 22	0.368	0.110	0.037
Rt 62	0.383	0.115	0.038
Rt 89a	0.885	0.266	0.088
5 dirt roads	0.290	0.090	0.030

[1]Hazards for crossings assuming different classes of warning devices

Class

1 - no signs or signals
2 - other signs
3 - stop signs
4 - crossbucks
5 - special protection (e.g. flagmen)
6 - highway signals, wigwags, and bells
7 - flashing lights
8 - automatic gates

TABLE G-6

GRADE-CROSSING HAZARD AT HIGH PRODUCTION LEVEL ACCIDENTS PER YEAR BY CLASS OF WARNING DEVICE[1]

Route	H_{1-4}	H_{5-7}	H_8
S. Kaiparowits/N. Kaiparowits to Page			
Rt 89g	1.024	0.307	0.102
S. Kaiparowits/N. Kaiparowits to Cedar City			
Rt 89g	1.024	0.307	0.102
Rt 67/89A	0.686	0.206	0.069
Rt 59	0.686	0.206	0.069
Rt 9	0.734	0.220	0.073
Rt 17	0.686	0.206	0.069
3 dirt roads	0.210	0.060	0.020
S. Kaiparowits/N. Kaiparowits to Milford			
Rt 20	0.544	0.163	0.054
Rt 89c	0.962	0.289	0.096
Rt 21	0.639	0.192	0.064
6 dirt roads	0.596	0.179	0.060
S. Kaiparowits to Salina			
Rt 12	0.805	0.241	0.080
Rt 22	0.423	0.127	0.042
Rt 62	0.450	0.135	0.045
Rt 89a	0.962	0.289	0.096
5 dirt roads	0.497	0.149	0.050

[1]Hazards for crossings assuming different classes of warning devices

Class

1 - no signs or signals
2 - other signs
3 - stop signs
4 - crossbucks
5 - special protection (e.g. flagmen)
6 - highway signals, wigwags, and bells
7 - flashing lights
8 - automatic gates

APPENDIX H

METHODOLOGY FOR SOCIO-CULTURAL ANALYSIS

Two basic research techniques were employed for the socio-cultural analysis. First of all, an extensive review was undertaken of the existing literature relevant to the study area. Several projects described in the literature included local attitude surveys or fairly detailed accounts of interviews conducted with key informants or other knowledgeable individuals residing in the study area. Also consulted were numerous historical accounts of the local communities in the area, including accounts of their founding and their patterns of growth and change over the years. Taken together, the rather large set of secondary source materials allowed the development of fairly detailed descriptions of local attitudes, norms, institutions, and patterns of community organization that characterize the area.

Second, the secondary analysis described above was supplemented by carefully developed discussions held with a number of key informants throughout the study area. The latter was used for three primary purposes: (1) to update existing socio-cultural studies that were already available from the literature review, (2) to fill important data gaps from previous research—for example, relevant variables such as those dealing with issues of community cohesion and integration were often omitted or inadequately treated in earlier analyses, and (3) to obtain data from potentially impacted communities that had not been covered in previous studies. Extensive work has been completed in such communities as Page, Arizona, and Kanab, Utah, for such previous projects as the National Science Foundation Lake Powell project, the impact studies conducted for the now defunct Kaiparowits Power Plant project, detailed Planning Area Analyses conducted by the Bureau of Land Management (BLM), regional coal studies conducted for the BLM and USGS, and wilderness studies conducted for the BLM. However, other smaller communities in Beaver County and in other areas of Kane and Garfield Counties such as Orderville, Glendale, Alton, and Antimony, have received limited or no attention in previous impact studies.

All of the discussions were conducted by the two senior researchers for the socio-cultural analysis. No structured instruments were used and the same questions were never asked to more than nine individuals in order that OMB clearance requirements would not be problematic. The discussions were always "guided" by the researchers such that relevant issues could be covered and adequate information could be accumulated on local attitudes and feelings.

A broad range of key informants were contacted. These included formal community leaders such as town councilmen, mayors, county commissioners, and so on. Also included were individuals who must deal with community problems and decisions on a regular basis such as local county sheriffs, town marshalls, school principles and superintendents, local planners, and other public service people such as social workers, family counselors, and so on. Contacts were also made with local religious leaders such as Bishops and members of Stake Presidencies. In all instances, persons were contacted in such a way that the attitudes and views could be generalized, in at least an informal manner, to the larger study area. Of course, no statistical sampling was done and no structured questionnaire data were obtained. In most instances, snowballing techniques were used after the initial contacts were made by asking those persons contacted to identify other informed individuals who should be contacted. Every effort was made to ensure that all relevant interests could be identified and represented in the analysis.

Because of the procedures employed, it was not possible to develop a detailed statistical analysis of local attitudes, values, and perceptions. Nevertheless, the report describing relevant socio-cultural conditions was based on multiple contracts and reviews and was consistent with the experience of the research team obtained from other studies in this area of the state.

APPENDIX I

ADDITIONAL MITIGATION MEASURES

The following mitigation measures were adapted from BLM Manual Section 2063, Appendix 3, entitled "Stipulations for Land Use Authorization."

Air

1. Grantee shall conduct all activities associated with the project system in a manner that will avoid or minimize degradation of air, land and water quality. In the construction, operation, maintenance, and termination of the project system, grantee shall perform all activities in accordance with applicable state and Federal air and water quality standards, related facility siting standards, and related plans of implementation, including but not limited to, standards adopted pursuant to the Clean Air Act, as amended, 42 U.S.C. § 1857 et seq., and the Federal Water Pollution Control Act, as amended, 33 U.S.C. § 1321 et seq.

2. Grantee shall utilize and operate all facilities and devices used in connection with the Project System so as to avoid or minimize air pollution and fog. Facilities and devices which cannot be prevented from producing fog shall be located so as not to interfere with airfields, communities or roads. Emissions from equipment, installations and burning materials shall meet applicable Federal and state air quality standards.

Soils

3. The grantee shall conduct all construction and maintenance activities in a manner that will minimize disturbance to vegetation, drainage channels, and streambanks. Construction methods shall be designed to prevent degradation of soil conditions in areas where such degradation would result in soil erosion or disturbance. Grantee shall take any other such soil and resource conservation and protection measures on the land covered by the grant as the authorized officer determines are necessary.

4. The erosion control facilities shall be constructed to avoid induced and accelerated erosion and to lessen the possibility of forming new drainage channels resulting from project system activities. The facilities shall be designed and operations conducted in such a way as to avoid or minimize disturbance to the thermal regime.

5. Surface materials taken from disturbed areas shall be stockpiled and utilized during restoration unless otherwise approved in writing by the authorized officer. Stabilization practices, as determined by the needs for specific sites, shall include but shall not be limited to seeding, planting, mulching, and the placement of mat binders, soil binders, rock or gravel blanket, or structures.

6. The grantee shall complete seeding, fertilizing, and mulching on cuts, fills, waste areas and other areas as designated by the authorized officer during the year prior to October 1 of each year. Seeding, fertilizing, and mulching will not be required on cut slopes in areas of rock material. The authorized officer may set time limits for the beginning and completion of erosion control measures. Seed, fertilizer, mulch, and suitable equipment to apply these materials shall be furnished by the grantee. The equipment and material shall be approved in writing by the authorized officer prior to the start of the seeding, fertilizing and mulching operation. The mixture shall be approved by the authorized officer. Seed which has become wet, moldy, or otherwise damaged, will not be used. All seed used shall meet all requirements of the Federal Seed Act (7 U.S.C. Secs. 1551-1610, incl.), and the seed laws, and noxious weed laws of the State. Evidence of seed certifi cation shall be furnished at the request of the authorized officer. All leguminous seeds will be inoculated with approved cultures in accordance with instructions of the manufacturer. The seeds used shall meet the following requirements:

Purity	95.0% minimum
Germination	85.0% minimum
Weed Content	0.5% maximum

Fertilizer shall be water soluble commercial fertilizer supplied in a combination containing the following ratio:

Available nitrogen	16%
Available phosporic acid	20%
Potassium	0%

Mulch shall consist of straw, hay, or specifically prepared wood cellulose fiber processed in such a manner that it contains no growth or germination inhibiting factors and shall be free of noxious weed seed.

7. The grantee shall apply grass seed, fertilizer, and mulch uniformly on designated areas at a rate specified by the authorized officer.

   No seed, fertilizer, or mulch shall be applied when wind velocities will prevent uniform application of the material on the designated areas.

Water Resources

8. The grantee shall comply with all applicable state and Federal laws and regulations pertaining to water quality in connection with operations under this grant.

9. The grantee shall take every reasonable precaution not to pollute or obstruct any stream, lake, or reservoir on or near the grant area in connection with any operations under this grant. If the grantee's operations cause pollution or obstruction of any stream, lake, or reservoir on or near the grant area, the grantee shall correct the condition to the satisfaction of the authorized officer. Grantee shall give immediate notice of any spill or leakage of soil or other pollutants from the project system, or any storage facility to: (1) the authorized officer; and (2) such other Federal and state officials as are required by law to be given such notice. Any oral notice shall be confirmed in writing as soon as possible.

10. The grantee shall not modify or change the character of streams, lakes, ponds, water holes, seeps, and marshes, except by advance approval in writing of the authorized officer, nor shall he in any way pollute such streams, lakes, ponds, water holes, seeps, or marshes.

11. All activities of grantee in connection with the project system that may create new lakes, drain existing lakes, significantly divert natural drainages, permanently alter stream hydraulics, or disturb significant areas of stream beds, are prohibited unless such activities along with necessary mitigation measures are approved in writing by the authorized officer.

12. Temporary access over stream banks shall be made through use of fill ramps rather than by cutting through stream banks, unless otherwise approved in writing by the authorized officer. Grantee shall remove such ramps upon termination of seasonal or final use. Ramp material shall be disposed of in a manner approved in writing by the authorized officer.

13. Mobile ground equipment shall be kept within the grant area and out of the waters of lakes, streams or rivers except as permitted by the authorized officer.

14. Grantee shall prevent or minimize erosion at stream and river crossings and those parts of the project system within floodplains.

15. Public Land areas used for temporary access roads, campsites, equipment storage, and other construction activities shall be restored by grantee to their natural state insofar as practicable and in accordance with a restoration plan approved by the authorized officer.

16. The grantee shall revegetate disturbed areas with native species in areas prescribed by the authorized officer.

17. Seeding and planting of disturbed areas shall be conducted as soon as practicable and, if necessary, shall be repeated until vegetation is successfully established, unless otherwise approved in writing by the authorized officer. All other restoration work shall be done as soon as possible, upon completion of operation and/or construction activities.

18. The grantee shall not use mechanical or chemical vegetal control measures in riparian zones along rivers, streams, meadows, or secondary drainages, unless approved by the authorized officer.

19. The grantee shall conduct surveys of the grant area to determine if any threatened or endangered species (flora and fauna) are present. If such species are found, the grantee shall take such measures to protect the species as prescribed by the authorized officer. Such measures may include temporary restrictions, seasonal restrictions, to all or part of the grant area.

20. Grantee's activities in connection with the project system in key fish and wildlife areas may be restricted by the authorized officer during periods of fish and wildlife breeding, nesting, spawning, fawning, or calving activity and during major migrations of fish and wildlife. Further restrictions in major big game wintering areas may also be required. The authorized officer shall give grantee written notice of such restrictive action. From time to time, the authorized officer shall furnish grantee with a list of areas where such actions may be required, together with anticipated dates of restriction.

21. Grantee shall inform his employees, agents, contractors, subcontractors and their employees, of applicable laws and regulations pertaining to hunting, fishing, and trapping (per particular state or area).

22. Grantee shall post the grant area prohibiting camping, hunting, fishing, trapping and shooting within the grant area. Grantee shall require its employees, agents, contractors, subcontractors, and their employees to refrain from engaging in such activities.

23. Any fence or other structure that might interfere with movements of big game or other wildlife must provide for wildlife passage and must otherwise meet established state and Federal standards. The proposed design shall be submitted to and approved by the authorized officer.

24. The grantee shall construct water facilities for range improvements, fire suppression, or other purposes in a manner that provides for wildlife uses.

25. The grantee shall construct powerlines so as to prevent electrocution of raptors. Any design approved by the authorized officer and declared safe by a raptor expert may be used.

26. All operations shall be conducted in such a manner as will avoid blockage of any drainage system; (b) changing the character, or causing the pollution or siltation of rivers, streams, lakes, ponds, waterholes, seeps, and marshes; and (c) damaging fish and wildlife resources or habitat. Cuts or fills causing any of the above-mentioned problems will be repaired immediately in accordance with specifications of the authorized officer.

27. The grantee shall install all culverts on live streams to permit the free passage of fish both upstream and downstream.

28. If material sites are approved adjacent to or in certain lakes, rivers, or streams, the authorized officer may require the grantee to construct levees, berms, or other suitable means to protect fish and fish passage and to prevent siltation of streams or lakes.

29. Grantee shall avoid channel changes in fish spawning beds designated by the authorized officer; however, where channel changes cannot be avoided in such beds, new channels shall be constructed according to written standards supplied by the authorized officer.

30. Fish spawning beds shall be protected from sediment where soil material is expected to be suspended in water as a result of construction activities. Settling basins shall be constructed to intercept silt before it reaches streams or lakes.

31. Grantee shall comply with any special requirements made by the authorized officer for a stream system in order to protect fish spawning beds and other elements of aquatic habitat essential in the life cycle of the species. Grantee shall repair all damage to fish spawning beds caused by construc tion, operation, maintenance, or termination of the project system.

32. Abandoned water diversion structures shall be plugged and stabilized to prevent fish from being stranded or trapped.

33. No blasting shall be done under water or within ¼ mile of streams or lakes without a permit from the appropriate State Department of Fish and Game, when such a permit is required by state law or regulation.

Cultural Resources

34. The grantee will not injure, alter, destroy, or collect any site, structures, objects or other properties of historical, archaeological, or other cultural values.

35. The grantee, prior to undertaking any surface-disturbing activities relating to this grant, unless specifically relieved of this requirement by the authorized officer, shall engage the services of a qualified professional archaeologist, acceptable to the authorized officer to:

    (a) Conduct an intensive cultural resource inventory for all evidence of scientific, archaeological, historical, or other cultural resource values within the areas to be disturbed.

    (b) Submit an acceptable report of the cultural resource inventory to the authorized officer. If cultural resources which cannot be avoided are located in the areas to be disturbed, the report shall include recommendations for mitigation.

    (c) Undertake such measures as deemed necessary by the authorized officer to mitigate any unavoidable effects of a proposed operation upon significant cultural resource values and the information they contain.

36. The grantee will bear all costs of conducting the cultural resource inventory, preparing the related report, and mitigating the effects of the proposed operation on significant cultural resources. All cultural resource material recovered from lands under the jurisdiction or control of a Federal agency shall remain the property of the United States Government; cultural resource material recovered from land that is not under the jurisdiction or control of a Federal agency shall remain the property of the surface landowner and subject to his disposition. Where cultural resources are found on non-Federal land, the land owner is responsible for administration of mitigation resources identified in the EAR/ES or easement stipulation.

37. The grantee shall immediately bring to the attention of the authorized officer any objects or resources of cultural or scientific value discovered as a result of operations under this grant, and shall leave such discoveries intact until permitted to proceed. The authorized officer will evaluate, or will have evaluated, such discoveries not later than five working days after being notified, and will determine what action will be taken with respect to such discoveries. Appropriate mitigation shall be undertaken prior to proceeding with any operations that might be destructive to a significant discovery. The responsibility for, and cost of, investigation and mitigation of adverse effects on cultural resources discovered during operations will be that of the grantee.

Visual Resources

38. Prior to initiation of planning and preconstruction phase, grantee shall secure the services of an individual trained in the environmental design arts (such as landscape architect or architects) to prepare the design and mitigation requirements for the project to meet the assigned visual resource management class and contract ratings requirements, as stated in BLM Manual Section 8423. If the contrast rating standards in BLM Manual Section 8423 attached and made part of the project cannot be met, the grantee shall submit to the authorized officer a written report analyzing the project impacts by features (landform/water, vegetation, structures) stating: (1) The exact location of the impact; (2) why the contrast rating standards cannot be met; and (3) grantee's proposal to minimize the impact of the necessary departures. The departure ratings must be approved in writing by the authorized officer.

39. The grantee shall restore the land to its original condition in accordance with laws and instructions as specified by the authorized officer, upon revocation or termination of the grant.

40. Grantee shall provide for the protection and enhancement of aesthetic values in

the planning, construction and maintenance of the project. Constructed facilities will have dull or nonreflective finishes that harmonize with their natural setting or that are otherwise appropriate. The authorized officer may require any additional reasonable measures he determines necessary to protect the aesthetic values in areas of critical environmental concern.

41. No construction activity in connection with the project system shall be conducted within mile of any officially designated Federal, state, or municipal park, wildlife refuge, research natural area, recreation area, recreation site, or any registered National Historic Site or National Landmark, unless such activity is approved in writing by the authorized officer.

42. Grantee shall not cut or remove any vegetative cover within a minimum 500-foot strip between highways or roads and material sites unless such cutting or removal is approved in writing by the authorized officer.

43. Where the right-of-way crosses a highway or road, a screen of vegetation native to the specific setting shall be established over disturbed areas, unless otherwise approved in writing by the authorized officer.

44. The project system shall be located so as to provide a 300-foot minimum buffer strip of undisturbed land along streams, unless otherwise approved in writing by the authorized officer.

45. Grantee shall consider aesthetic values in planning, construction, and operation of the project system. Where the right-of-way crosses a highway or road in forested terrain, the straight length of the project visible from the highway or road shall not exceed 600 feet in length, unless otherwise approved in writing by the authorized officer. The authorized officer may impose such other requirements as he determines necessary to protect aesthetic values.

46. Grantee shall permit free and unrestricted public access to and upon the right-of-way for all lawful and proper purposes, except in areas designated as restricted by grantee with the consent of the authorized officer in order to protect the public safety and facilities constructed on the right-of-way.

47. During construction, grantee shall regulate public access and vehicular traffic, as required, to facilitate construction operations and to protect the public, wildlife, and livestock from hazards associated with the project. For this purpose, grantee shall provide warnings, flag men, barricades and other safety measures requested in writing by the authorized officer.

48. Grantee shall protect existing telephone, telegraph and trans missionlines, roads, trails, fences, ditches, and like improvements during construction, operation, maintenance and termination of the project system.

49. Grantee shall not obstruct any road or trail with logs, slash, or debris. Damage caused by grantee to public utilities and improvements shall be promptly repaired by grantee to a condition satisfactory to the authorized officer.

50. All vehicles shall be operated at a reasonable rate of speed and, in the operation of vehicles, due care shall be taken to safeguard livestock and wildlife in the vicinity of operations. Existing roads and trails shall be used wherever possible. If new roads and trails are to be constructed, the authorized officer must approve in writing the location and specifications of construction. Reclamation and/or reseeding of new roads and trails shall be done as directed by the authorized officer.

51. Grantee will be responsible for providing and installing caution and regulatory signs that are necessary for the safety of users of access roads.

Socio-Cultural Aspects

52. Grantee shall take all measures necessary to protect the health and safety of all persons affected by activities performed in connection with the construction, operation, maintenance, or termination of the project system, and shall immediately abate any health or safety hazards. Grantee shall immediately

notify the authorized officer of all serious accidents which occur in connection with such activities.

53. The grantee shall conduct all grant operations in compliance with the applicable provisions of Federal, state, and local safety, health and sanitation laws, codes, and regulations and shall make it possible for the authorized officer to inspect such operations.

54. The grantee shall comply with all applicable state and Federal laws and regulations concerning the storage, handling, use, and disposal of industrial chemicals, pesticides, herbicides, and other hazardous substances.

55. All waste generated in construction, operation, maintenance and termination of the project system shall be removed or otherwise disposed of in a manner acceptable to the authorized officer. All applicable standards and guidelines of the appropriate state, the United States Public Health Service, the Environmental Protection Agency, and other Federal and state agencies, shall be adhered to by the grantee. All incinerators shall meet the requirements of applicable Federal and state laws and regulations, and shall be used with maximum precautions to prevent forest and range fires. After incineration, material not consumed in the incinerator shall be disposed of in a manner approved in writing by the authorized officer. Portable or permanent waste disposal systems to be used shall be approved in writing by the authorized officer.

APPENDIX J

AIR QUALITY/VISIBILITY MITIGATION MEASURES

Regional and local modeling results show that unacceptable air quality and visibility impacts could occur at all three coal development levels with unmitigated emissions. In the relatively undeveloped southern Utah region, the foremost pollutant is suspended particulate matter; current and projected impacts of gaseous pollutants are relatively minor. On a local scale, surface and underground coal mining operations represent the most significant sources of particulate matter with the development scenarios and these produce the maximum impacts on standards and increments. Region-wide, however, significant sources include:

- surface and underground mining operations,
- unpaved county roads, and
- regional coal transportation systems.

These three types of sources have the potential to produce significant impacts on both regional visibility and the Class I increments in nearby national parks. However, mining operations remain the primary source of particulates within the study area and, unmitigated, produce localized "hot spots" superimposed on the overall regional particulate levels.

Based on the results of the local modeling analyses for TSP emissions from mining operations, Table J-l presents the estimated fraction of coal production possible for each development scenario without the inclusion of pollution control techniques. As shown in the table, potential air quality impacts can severely limit coal production in southern Utah.

The following discussion of mitigation techniques will focus on particulate emissions, specifically fugitive dust. Fugitive dust composes the bulk of the particulate emissions in the study region; it is the major pollutant produced by mining activities, primarily during haulage and large-scale earth-moving operations. Unpaved roads emit fugitive dust and it is produced during coal transport in the form of blow-off and wake reentrainment. The final portion of this section will examine mitigation methods for urban sources of pollutants including gaseous pollutants. This information could be useful to avoid localized pollution problems associated with the urbanization which will accompany coal development.

Control of Fugitive Dust Sources

The measures available for mitigating fugitive dust sources are generally based on reducing the potential for dust emissions at the source rather than removing particulate matter from the contaminated air stream. The reason for this is the open, spatially extensive nature of most fugitive dust sources; fugitive dust is not emitted in a confined flow stream which can be easily manipulated. Mitigation techniques for fugitive dust sources range from preventive measures which limit the disturbance of the dust-producing material to modifications of the emitting surface to physically confining the emission source. Five levels of dust mitigation have been defined:

- Level I -best management practices
- Level 2 - wet suppression
- Level 3 - chemical stabilization
- Level 4 - physical stabilization
- Level 5 - dust removal techniques

Each successive mitigation level is more efficient in controlling dust sources than the preceding level, but each is also more demanding to implement in terms of time and money. In addition, as the control methods become more rigorous, their applicability to a wide variety of dust sources declines. Net effectiveness does not necessarily increase equally for all sources when moving to a higher level of control; dust emissions, and thus control effectiveness, are dependent on too many variables. Tables J-2 through J-6 present, for each level, the control methods identified for the source types anticipated to accompany coal development in southern Utah.

In addition to dust control methods, dusting potential at a mine can be reduced through modifications to the plan of operations. For example, in this study, the assumed truck size at all development levels is 25 tons. If I50-ton trucks were used instead, each truck trip would move a greater load and the total number of truck trips would be reduced. Thus, the number of miles traveled over unpaved roads would be reduced, sharply cutting the haul road emissions. The fractional reduction

would be inversely proportional to the ratio of the actual truck capacity to the assumed truck capacity; or, getting back to the example:

$$\frac{\frac{1}{150 \text{ ton}}}{25 \text{ ton}} = \frac{1}{6} .$$

This represents a dust emissions reduction of 83 percent.

However, vehicle weight has also bee found to influence the emissions produced per mile by truck movement on unpaved roads. Field sampling has shown that, for the weight range examined in this study (from 25- to 150-ton trucks), emissions in pounds per truck mile could vary by a factor between 2 and 4, with all other parameters being held constant (PEDCo 1978 and Bonn et al. 1978). Thus, it may be possible that while increasing the size of haul trucks used at the mining operations would result in a net decrease in emissions, the effectiveness of this measure to reduce emissions may be constrained. But the problem is more complex because there are several other factors influencing the haul road emissions. These include:

- Vehicle speed (greater emissions at higher speeds);
- Width and type of tire tread (wider tires will apply more force to the road surface and raise a greater quantity of dust);
- Composition of road surface (a gravel surface produces more finely divided particles than newly laid scoria but an old scoria* surface produces more than either);
- Climatological moisture (a higher moisture content in the road surface will inhibit dust emissions); and
- Average wind speed (a greater wind speed will permit more disturbed or loose material to become airborne).

The emission factor used to calculate haul road emissions for mining operations in the Kaiparowits region is an average of factors derived during a field sampling program at four different mines in the Rocky Mountain region (PEDCo 1978). These parameters which govern haul road emissions were not equivalent at all four mines. A difference in emission rates which might be attributable to differences in truck sizes could also be produced by differences in truck speed, tire size, local climato logy or average wind speed during each sampling period.

Essentially, any dust emission rate should be site specific, taking into account the individual characteristics of each mine and its environment. Since this detailed information was not readily available for each lease area studied in the Kaiparowits region, it was not possible to calculate site-specific emission factors and the factors selected and mitigation measures applied represent a best estimate of dust emissions from mining operations in the Kaiparowits region including the net effect (83 percent control) of increasing the truck size.

Another operational mitigation technique would be replacing the truck haulage of coal by a fixed conveyor system. This would eliminate one of the largest dust emission sources and replace it with one that may be more easily controlled through chemical sprays or covering. Conveyor systems, however, require a large capital investment at the start of mining and may not be feasible for long transport distances.

Since mining emissions represent the major emission source within the future development scenarios, these tables provide a greater number of control techniques that are applicable to mining sources than to any other source classification. Sources of dust within the mining operations should be the first addressed in any mitigation analyses that would be part of a permitting process.

Additional dust mitigation techniques are available for regional scale sources outside the mine lease areas. These sources are addressed in the mitigation Tables J-2 through J-6 as Coal Transport and Secondary Sources. Mitigation of these source classes could have a significant impact on regional particulate levels and could easily provided

*In situ clay baked to brick by underground coal fires; this is a commonly used road building material in many coal-bearing regions, especially the Powder River Basin in northeast Wyoming.

emission trade-offs within the Kaiparowits development area.*

Effect of Dust Mitigation on Local Impacts

It was determined that an emission reduction corresponding to approximately 88 percent of the unmitigated mining emissions should result in acceptable air quality impacts. Reasonable techniques include:

- an increase in the size of haul trucks from 25 tons to 150 tons;
- chemical stabilization of the coal haul roads;
- enclosure of the coal dump hopper at the processing facility, including a negative pressure device;
- enclosure of the coal surge pile with venting through a fabric filter system (baghouse);
- water spray grader and scraper activities during the construction and revegetation operations;
- enclosure of crusher operations with venting through a fabric filter system (baghouse); and
- dust collection hoods for the mining drill.

Except for the chemical stabilization of the haul road surfaces, all of these methods are generally used at large surface coal mining operations, though not necessarily for the prevention of adverse air quality impacts. Some are simply standard engineering practice or are done for safety reasons. For example, enclosing the coal surge pile and crusher facility and venting through a baghouse ensures that, from an engineering standpoint, product loss will be minimized. Also, most of the state regulatory agencies in the west currently require some or all of these measures as best available control technology during the permitting process. The use of chemical stabilizers on haul roads is rapidly becoming a standard regulatory requirement and is currently undergoing studies by both industry and government. In addition, the technology for chemical control of dust emissions from unpaved roads at surface mining operations already exists.

These combined mitigation measures would be effective in reducing the unmitigated particulate emissions from the three mining operations at least by 88 percent. The effect on particulate emissions resulting from mining operations at each lease area is shown in Table J-7 for the mine-related sources during the high scenario.

Effects of Dust Mitigation on Regional Impacts

On the regional scale, additional mitigation measures applied outside of the mine lease areas were found to be necessary to achieve acceptable air quality levels. These additional measures include:

- Reduction of approximately 85 percent of the unpaved road emissions in Garfield and Kane Counties through paving of the most heavily traveled rural roads;
- Revegetation of transportation corridors concurrently with construction; and
- Spraying loaded pulverized coal with an emulsive binder to reduce coal blow-off emissions from loaded haul trucks traveling along transportation corridors by 90 percent.

The regional emission reduction is summarized in Tables J-8 through J-10 for low, medium, and high development scenarios, respectively. Pavement of some county roads will probably be a direct result of county growth in conjunction with coal development. It is assumed here that pavement of the most heavily traveled roads combined with a change from rural to urban lifestyles would result in an emission reduction of approximately 75 percent. The use of chemical binders on loaded rail cars is common in many coal transport situations and could be easily adapted to trucks. In general, the primary reason for reducing coal blow-off is to

*The Utah State Department of Transportation already has a policy in which the mine operator advances funds to construct the road from the mine to the railhead or power plant and is then exempt from state sales tax for the years necessary to refund the advance. (Telephone communication with Mr. John McKuen, 22 October 1979.) A similar policy for the paving of county roads could also be developed.

prevent product loss. Revegetation of transportation corridors as construction proceeds is a good management practice for dust control along transportation routes.

The effect of mitigation was presented with the regional modeling results in Chapter 4. Overall maximum concentrations were reduced by an average of 70 percent for all three development levels. Large-scale regional patterns of concentrations were relatively unchanged from the unmitigated case, but local high concentrations near the mine lease areas were eliminated.

The effects of the mitigation techniques on possible coal production levels are presented in Table J-11. Similar to Table J-l, this table shows the fraction of anticipated coal production possible for the mitigated case.

Gaseous Pollutants

At present, since southern Utah is primarily rural with little industrial development, pollutants other than particulates are not of concern. However, with the development of the region's coal resources and the associated rise in population, emissions of SO_x, NO_x, HC, and CO could increase by as much as a factor of 20. The impacts of this large increase in emissions would be very localized and not region-wide, since growth induced by the development should be limited to specific communities close to the coal areas such as Escalante, Kanab, and Glen Canyon City. The rapid growth induced by mine construction and operation could precipitate many of the air quality problems found in urban areas today.

Vehicle emissions currently account for an average of about 70 percent of the gaseous emissions; 60 percent of the reactive HC emissions, l00 percent of the nonreactive HC emissions, 80 percent of the NO_x and CO emissions, and 20 percent of the SO_x emissions. Even with the advent of industries and services to support the coal development and the growing population, mobile sources would emit most of the gaseous pollutants. Unless major emitting industries also settle in the study region, there is little evidence that this ratio would change substantially.

Mitigation measures to reduce urban/population related emissions of gaseous pollutants can be adapted from plans used in other urban areas with similar problems. A major factor relating to the feasibility of air pollution control in southern Utah is that the chosen methods can be included in the regional planning process; unlike most developments, the solution can be applied before the problem arises. Table J-12 presents various measures which can easily be incorporated in city/county plans or local air quality control regulations to aid in reducing the potential for air pollution. Alternative methods that could be investigated as to feasibility of adaption in southern Utah are presented in Table J-13.

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TABLE J-1

FRACTION[a] OF COAL PRODUCTION POSSIBLE IN EACH LEASE AREA WITHOUT THE APPLICATION OF DUST MITIGATION TECHNIQUES

	Anticipated Coal Production (MTPY)	NAAQS				PSD Increments			
		Primary		Secondary		Class I		Class II	
		Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr
Low									
Alton	2	1.0	1.0	1.0	0.81	0.50	0.20	0.54	0.21
K. North	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
K. South	2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Medium									
Alton	9	0.48	0.30	0.39	0.18	0.10	0.05	0.12	0.06
K. North	15	1.0	1.0	0.84	1.0	0.40	0.40	0.27	0.24
K. South	30	1.0	0.54	0.81	0.33	0.40	0.20	0.24	0.12
High									
Alton	9	0.48	0.30	0.39	0.18	0.10	0.05	0.12	0.06
K. North	30	0.54	0.87	0.42	0.51	0.20	0.20	0.12	0.12
K. South	45	0.66	0.36	0.54	0.21	0.20	0.20	0.18	0.06

[a]Based on anticipated coal production levels shown in the first column.

TABLE J-2

BEST MANAGEMENT PRACTICES

Source Class	Source Type	Control Method	Estimated Control Efficiency	Reference[a]	Comments
Mining	Blasting	Minimize area to be blasted	—		Control effectiveness is a function of the area.
		Avoid overshooting	—		
	Coal and waste handling	Minimize fall distance	—		
	Truck unloading (at an open pile)	Unload on downwind side using pile as a windbreak	—		
	Storage pile loadout	Stacker/reclaimer	25-50%	b	
	Storage pile wind erosion	Wind screens	—		Very poor control efficiency (Carpenter and Weant 1978)

TABLE J-2 (Continued)

Source Class	Source Type	Control Method	Estimated Control Efficiency	Reference[a]	Comments
	Wind erosion	Wind breaks	50%	c	
		Minimize stripped areas	—		
		Furrow areas	—		
		Revegetate rapidly	75%	c	Within 1 growing season
	Haul roads	Minimize distance traveled	—	c	Within 1 growing season
		Maintain road surface and remove loose debris	—		
		Restrict travel to maintained roads	—		
		Speed control	25% for 30 mph 65% for 20 mph 80% for 15 mph	d	Assuming the uncontrolled speed is 40 mph. Dust emissions are linearly proportional to vehicle speed for speeds from 30 to 50 mph. Below 30 mph, emissions are proportional to the square of the vehicle speed (EPA 1975).
Coal Transport	Unpaved roads	Minimize distance traveled	—		
		Maintain road surface and remove loose debris	—		
		Restrict travel to maintained roads	—		
		Speed control	(see above)		
Secondary Sources	Construction	Minimize exposure of Stripped areas	—		
	Unpaved roads	(see above)			
	Sanding paved roads for snow and ice control	Replace sand with salt or a sand/salt mixture	—		
		Plow streets instead of sanding	—		
		Clear sanding material as soon as possible after each storm	—		
		Restrict sand application to intersections, hills and curves	—		
		Wash and size sand			

[a]Reference Numbers given refer to footnotes.
[b]Jutze et al. 1977.
[c]EPA 1979.
[d]EPA 1975.

TABLE J-3
WET SUPPRESSION

Source Class	Source Type	Control Method	Estimated Control Efficiency	Reference[a]	Comments
Mining	Topsoil stripping	Watering	50%	b	
	Drilling	Water injection system	90%	c	
	Shovel excavation	Watering	—		Continuous activity reduces effective control (Carpenter and Weant 1978)
	Windage and spillage from loaded haul trucks	Wetting surface	—		Temporary but may be effective for short hauls
	Truck unloading	Water spray system	50%	c,d	Only applicable if a wet product can be tolerated
	Storage pile load-in/loadout	Water spray	50%	c,d,e	Continuous activity reduces effective control (Carpenter and Weant 1978)
	Storage pile maintenance	Watering	50% 40%	c f	Watering is useful mainly to reduce emissions from vehicular traffic in the storage pile area. Watering of the storage piles themselves typically has only a very temporary effect on total emissions (EPA 1975)
	Storage pile wind erosion	Watering	50%	c,d	Temporary
	Haul roads	Watering	50%	d,e	Temporary
Coal Transport	Unpaved roads	Watering	50%	d,e	Temporary
	Intransit windage	Wetting surface	—		Temporary, ineffective for long hauls (Carpenter and Weant 1978)
Secondary Sources	Construction	Watering	30%		Average control efficiency with daily watering and complete coverage. Extensive wetting at the construction site may reduce emissions up to 60-70%. There is a negative trade-off, however, associated with watering at a construction site; mud carried out into the adjacent street is susceptible after drying to suspension in the wake of passing vehicles.
	Unpaved roads	Watering	50%	d,e	Temporary

[a]Reference Numbers given refer to footnotes.
[b]PEDCO 1976.
[c]EPA 1979.
[d]Collins 1979.
[e]Jutze et al. 1977.
[f]EPA 1975

TABLE J-4

CHEMICAL STABILIZATION

Source Class	Source Type	Control Method	Estimated Control Efficiency	Reference[a]	Comments
Mining	Truck unloading	Chemical wetting agent	90%	b	
	Storage pile loadin/loadout and maintenance	Chemical stabilization	L90%	b	Continuous chemical treatment of material loaded onto piles, coupled with watering or similar treatment of roadways, can reduce total particulate emissions from storage operations by up to 90% (EPA 1975). But other surveys claim that, as with watering, constant movement of material in and out of the storage pile negates the dust control effectiveness of chemical treatment. (Carpenter and Weant 1978)
	Storage pile wind erosion	Chemical stabilization	90%	b	For active piles, the actual degree of effectiveness is probably dependent on the amount of disturbance and fracturing of the crust formed by the chemical agent. (Carpenter and Weant 1978)
	Wind erosion	Chemical stabilization	85%	c	May interfere with later revegetation
	Haul roads	Chemical stabilization	85% 65% 50% 50%	c d b e	Control efficiency of a chemical dust suppressant on a roadway is extremely variable depending on the chemical used, method of application, dilution ratio, frequency of application, and type and amount of traffic. For heavily traveled roads, frequent retreatments are required for this method to be effective
Coal transport	In-Transit windage	Chemical binders	L90%	f	Control effectiveness depends on length of exposure and total wind velocity coal particles are subjected to. (Control efficiency estimated by ERT from results of wind tunnel tests.) Other studies indicate that effectiveness of a chemical binder to control in-transit dust

TABLE J-4 (Continued)

Source Class	Source Type	Control Method	Estimated Control Efficiency	Reference[a]	Comments
					losses is dependent on the loading profile or geometric configuration of the exposed coal surface, the loading method, and the chemical application technique.
	Unpaved roads	Chemical stabilization	(see haul roads above)		
Secondary sources	Construction	Chemical soil stabilization			Primarily effective in controlling windblown dust from exposed areas
	Unpaved roads	Chemical stabilization	(see haul roads above)		

[a]Reference numbers given refer to footnotes.
[b]Jutze et al. 1977
[c]EPA 1979
[d]Collins 1979
[e]EPA 1975
[f]Nimerick and Laflin 1977

TABLE J-5

PHYSICAL STABILIZATION

Source Class	Source Type	Control Method	Estimated Control Efficiency	Reference[a]	Comments
Mining	Windage and spillage from loaded haul trucks	Tarpaulin cover	—		The effectiveness of this method in controlling the loss of material from loaded haul trucks has been rated fair (Carpenter and Weant 1978). One primary concern is that covering the truck loaded during onsite hauling could cause delays during the loading and unloading process
	Truck unloading	Enclosure	70-99%	b	The control efficiency depends on the type of enclosing structure (full or partial) and on any additional venting equipment. This method can be costly.
	Storage piles	Enclosed or covered storage	95-99% 99%	c d,e	These control efficiencies represent fully enclosed storage; the effectiveness of a partial enclosure or cover is probably less. Full enclosure may not be practical for all types of storage because of cost.

TABLE J-5 (Continued)

Source Class	Source Type	Control Method	Estimated Control Efficiency	Reference[a]	Comments
		Separate storage of finely divided material	—		Control effectiveness is dependent on the size of material left in open storage; but feasibility and cost effectiveness is dependent on minimizing the amount of material put in the enclosed storage. The screening process itself, unless carefully controlled, may contribute more to airborne particulate than is removed through separate storage of fines.
	Haul roads	Paving	85% 85-100%	b,e d	Lower control efficiency (70%) is given to a chip seal surface (Collins 1979). Test study in Maricopa County, AZ, showed paving to be 100% effective in controlling dust on a formerly unpaved road. However, cost can be substantial.
Coal Transport	Unpaved roads	Paving	(see above)		
Secondary sources	Unpaved roads	Paving	(see above)		
	Unpaved road shoulders	Curbing	75%	f	Curbing is primarily within population centers; but since the major portion of vehicle miles are travelled within the towns, street improvements there will have far greater impact on regional particulate levels than would similar improvements on county roads.

[a]Reference numbers given refer to footnotes.
[b]Jutze et al. 1977.
[c]EPA 1975.
[d]EPA 1979.
[e]Collins 1979.
[f]Richard and Safriet 1977.

TABLE J-6

TECHNIQUES USING PARTICLE REMOVAL DEVICES

Source Class	Source Type	Control Method	Estimated Control Efficiency	Reference[a]	Comments
Mining	Drilling	Hooded dust collection system	90%	b	
	Truck unloading (hopper)	Negative pressure system	85%	b,c	Large fans draw air with fine particles down into the hopper preventing them from becoming airborne.
	Storage pile	Baghouse	99%	d	Fabric filtration system which removes dust particles from the enclosed air before venting to the atmosphere. Must be accompanied by a fully enclosed structure.
Secondary Sources	Paved roads	Street cleaning	—		Street cleaning has not been proved to be an effective method for reducing ambient particulate concentrations; street cleaning only reduces the street dust available for reentrainment and dust reentrainment is not a significant source.

[a]Reference numbers given refer to footnotes.
[b]EPA 1979.
[c]Collins 1979.
[d]PEDCO 1976.

TABLE J-7

EMISSION MITIGATION FOR MINING SOURCES HIGH COAL DEVELOPMENT LEVEL - YEAR 2001

	Unmitigated Emissions (TPY)			Estimated Control Efficiency	Reference Table	Mitigated Emissions (TPY)		
	Alton	N. Kaip.	S. Kaip.			Alton	N. Kaip.	S. Kaip.
I. CONSTRUCTION								
1. Exposed Areas	—	a	a	—	—	—	a	a
2. Topsoil Removal	92.4			50%	703	46.2		
3. Grader Operation	187.2			50%	703	93.6		
II. UNDERGROUND MINING		*South*					*South*	
1. Haul Road Traffic Coal	b	90,720.0	252,000.0	92%	704	b	7257.6	20160.0
2. Truck Dump Coal Surge		229.6	382.9	85%	7-5		34.5	57.4
3. Pile Blow Off		326.2	458.7	99%	705		3.3	4.61
4. Exposed Areas	180.0	315.0	—	—			180.0	315.0
5. Train/Truck Loading	2.7	4.5	—	—			2.7	4.5
6. Front End Loader	1620.0	2700.0	—	—			1620.0	2700.0
7. Grader	124.8	124.8	50%	703			62.4	62.4
8. Spoils Dump	0.0	1.4	—	—			0.0	1.4
9. Haul Road Traffic, Spoils	340.2	567.0	92%	7-4			27.2	45.4
10. Crusher, Train	1080.0	1800.0	99%	7-6			10.8	18.0
11. Road Maint.	3.2	4.8	50%	7-3			1.6	2.4
III. SURFACE MINING		*North*					*North*	
1. Dragline	661.5	—	d	—	—	661.5	—	d
2. Haul Road Traffic, Coal	30240.0	8400.0		92%	7-4	2419.2	672.0	
3. Shovel Truck Loading, Coal	15.8	588.0		—	—	15.8	588.0	
Overburden	—	—		—	—	—	—	
4. Blasting Overburden	62.6	20.9		—	—	62.6	20.9	
5. Blasting Coal	62.6	20.9		—	—	62.6	20.9	
6. Truck Dump	76.6	25.5		85%	7-5	11.5	3.8	
7. Coal Surface Pile Blow Off	0.0	75.4		99%	7-5	0.0	0.8	
8. Exposed Areas	212.4	82.8		—	—	212.4	82.8	
9. Drilling	92.9	31.0		90%	7-6	9.3	3.1	
10. Train/Truck Loading	—	0.3		—	—	—	0.3	
11. Front End Loader	540.0	180.0		—	—	540.0	180.0	
12. Overburden Dump	94.5	31.5		—	—	94.5	31.5	
13. Haul Road Traffic Overburden	36690.0	13230.0		92%	7-4	2935.2	1058.4	
14. Crusher - Train	—	1080.0		99%	7-4	2935.2	1058.4	
15. Pipeline - Loadout Crusher	360.0	—		99%	7-6	3.6	—	
16. Road Maint.	13.5	3.2		50%	7-3	6.8	1.6	
IV. RECLAMATION		*North*	*South*				*North*	*South*
1. Exposed Areas	168.8	82.8	180.0 315.0	—	—	168.8	82.0	180.0 315.0
2. Topsoil Replacement	221.0	294.4	184.0 2760.0	50%	7-3	110.5	147.2	92.0 1380.0
Revegetating Tillage	149.7	40.9	365.0 693.5	50%	7-3	74.9	20.5	182.5 346.8
TOTAL	69879	24167	95356 262128			7466	2904	96.55 25413
% Control	—	—	— —			(89%)	(88%)	(90%) (90%)

a. No construction activities anticipated at the North and South Kaiparowits lease areas during 2001.

b. No underground mining at the Alton lease area during 2001.

c. Control efficiency for haul road traffic includes 83% mitigation for larger haul trucks and 50% mitigation for use of a chemical stabilizer.

d. No surface mining at South Kaiparowits lease area.

TABLE J-8

REGIONAL RSP SOURCE EMISSIONS - LOW SCENARIO (2001) (gm/sec)

Source	Unmitigated RSP	Mitigated RSP	Method of Mitigation	Emission Reduction
Kane County rural	690	187	paving rural roads	73%
Garfield County	1380	480	paving rural roads	65%
Alton	199	24.4	a	88%
N. Kaiparowits	43.2	4.4	a	90%
S. Kaiparowits	140	14.1	a	90%
Truck Haul S. Kaiparowits to Cedar City	24.8	6.6	chemical binder	73%
Truck Haul Alton to Warner Valley	13.1	2.3	chemical binder	82%
Truck Haul N. Kaiparowits to Milford	11.3	2.0	chemical binder	82%

[a]Mitigation measures assumed to mines are given in detail in the text.

TABLE J-9

REGIONAL RSP SOURCE EMISSIONS - MEDIUM (gm/sec)

Source	Unmitigated RSP	Mitigated RSP	Method of Mitigation	Emission Reduction
Kane County rural	1100	320	paving rural roads	71%
Garfield County rural	886	270	paving rural roads	70%
Alton	650	100	a	85%
N. Kaiparowits	0	0	—	—
S. Kaiparowits	1510	211	a	86%
Rail Haul S. Kaiparowits to Milford	119	35.2	Chemical binder	70%
Pipeline Construction N. Kaiparowits to Nephi	14.1	14.1	—	—
Pipeline Construction Alton to Warner Valley	27.5	27.5	—	—

TABLE J-10

REGIONAL RSP SOURCE EMISSIONS - HIGH SCENARIO (gm/sec)

Source	Unmitigated RSP	Mitigated RSP	Method of Mitigation	Emission Reduction
Kane County rural	2198	637	paving rural roads	71%
Garfield County rural	5922	1717	paving rural roads	71%
Alton	648	100	a	85%
N. Kaiparowits	975	150	a	85%
S. Kaiparowits	2256	312	a	86%
Rail Haul N. Kaiparowits to Salina	78	26	chemical binder	67%
Rail Haul S. Kaiparowits to Milford	192	37.2	chemical binder	81%
Slurry Pipeline Alton to Warner Valley	0	0	—	—

TABLE J-11

FRACTION[a] OF COAL PRODUCTION POSSIBLE IN EACH LEASE AREA WITH THE APPLICATION OF DUST MITIGATION TECHNIQUES

		NAAQS				PSD Increments			
		Primary		Secondary		Class I		Class II	
	Anticipated Coal Production (MTPY)	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr
Low									
Alton	2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
K. North	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
K. South	2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Medium									
Alton	9	1.0	1.0	1.0	1.0	0.90	0.30	1.0	0.36
K. North	15	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
K. South	30	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.66
High									
Alton	9	1.0	1.0	1.0	1.0	0.90	0.30	1.0	0.36
K. North	30	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
K. South	45	1.0	1.0	1.0	1.0	1.0	0.80	1.0	0.42

[a]Based on anticipated coal production levels shown in the first column.

TABLE J-12

MITIGATION MEASURES FOR INCLUSION IN REGIONAL DEVELOPMENT PLANS

Mitigation Technique	Pollutants Affected
Electrify railroad switching yards	RHC, NO_x, CO, Part
Increase use of available rail, air and bus for intercity travel	RHC, NO_x, CO, Part
Traffic signal synchronization	RHC, NO_x, CO
Improve traffic flow through the use of one-way streets and intcrsection modifications	RHC
Develop ride-sharing programs	RHC, NO_x, CO, SO_x, Part
Develop community plans and zoning policy to integrate land uses and reduce the number of trips	RHC, NO_x, CO, SO_x, Part
Restrictions on truck travel during peak transit periods	RHc
Require increased trucking efficiency	RHC
Require use of emulsified asphalt (water-base) in asphalt applications	RHC
Prevent highway congestion through widening in high use areas	RHC, NO_x, CO
Require purchase of low emission, high fuel economy vehicles for government use	RHC, NO_x, CO
Require regular low emissions tune-up for government vehicles	RHC, NO_x, CO
Require city/county purchasing agents to procure low pollutant combustion equipment and nonreactive solvents, degreasers, and paints	RHC
Develop alternatives to incineration for solid waste handling	RHC, NO_x, CO, SO_x, Part
Require valve maintenance schedule to prevent fugitive emissions from industrial process	RHC
Require use of non-volatile coating in machinery maintenance	RHC
Require filter collection of particles in woodworking and related industries	Part

TABLE J-13

ALTERNATIVE MITIGATION MEASURES WHICH REQUIRE FURTHER STUDY

Mitigation Technique	Pollutants Affected
Electric vehicles	RHC, NO_x, CO, SO_x, Part
Regional transit system	RHC, NO_x, CO, Part, SO_x
Alternative design of new residential space heaters	NO_x
Alternative design of new residential water heaters	NO_x
Emission controls on medium and small steam generators	NO_x
Emission controls on industrial boilers	NO_x
Emission controls on stationary internal combustion engines	NO_x
Voluntary retirement of older cars	RHC, NO_x, CO
Blending motor fuel with methanol and/or ethanol	RHC, NO_x, CO
Annual vehicle inspection and maintenance program	RHC, NO_x, CO

APPENDIX K

SOCIOECONOMICS DATA

TABLE K-1
GARFIELD COUNTY - DISAGGREGATION OF BASELINE POPULATION PROJECTIONS TO COMMUNITIES

	Garfield County	Antimony	Boulder	Cannonville	Escalante	Hatch	Henrieville	Hite	Panguitch	Ticaboo	Tropic	County Area
1970*	3,157	113	93	113	638	139	145	3	1,318	0	329	266
1980	4,889	121	115	117	665	145	185	3	1,784	1,000	395	350
1981	5,243	120	117	118	673	145	190	3	1,919	1,200	408	352
1982	5,520	118	118	119	680	146	195	3	1,984	1,400	416	355
1983	5,859	118	120	120	688	147	201	3	2,083	1,600	425	357
1984	6,155	117	121	122	695	148	206	3	2,153	1,800	434	360
1985	6,512	117	123	124	705	148	212	3	2,279	2,000	444	363
1986	6,580	116	125	125	711	147	220	3	2,317	2,000	454	366
1987	6,706	116	127	127	720	148	228	3	2,404	2,000	465	370
1988*	6,754	115	129	129	729	149	235	3	2,417	2,000	476	375
1989*	6,864	115	131	132	738	149	244	3	2,489	2,000	487	380
1990	6,940	114	132	135	750	150	254	3	2,520	2,000	499	386
1995*	7,213	110	140	142	755	150	280	3	2,698	2,000	535	403
2000	7,616	105	150	152	760	150	310	3	2,990	2,000	575	425

Source: Five-county 1980

TABLE K-2

KANE COUNTY - DISAGGREGATION OF BASELINE POPULATION PROJECTIONS TO COMMUNITIES

	Kane County	Alton	Glendale	Kanab	Mt. Carmel	Orderville	County
1970[1]	2,421	62	200	1,381		399	379
1980	4,511	54	203	3,225	95	411	523
1981	4,743	52	209	3,415	95	422	550
1982	4,955	54	213	3,582	99	431	575
1983	5,180	52	218	3,765	104	440	600
1984	5,429	54	223	3,963	108	450	629
1985	5,687	51	227	4,174	113	460	660
1986	5,916	53	231	4,366	118	467	686
1987	6,144	55	233	4,552	122	473	712
1988	6,361	51	237	4,732	127	477	738
1989	6,578	53	243	4,907	131	480	763
1990	6,774	54	250	5,060	135	487	785
1995	7,590	53	280	5,715	151	508	880
2000	8,764	53	315	6,660	175	543	1,016

Source: Five-County 1980
[1]Census data

TABLE K-3

BEAVER COUNTY - DISAGGREGATION OF BASELINE POPULATION PROJECTIONS TO COMMUNITIES

	Beaver County	Beaver City	Milford	Minersville	County Area
1970[1]	3,800	1,453	1,304	448	595
1980	4,563	1,780	1,551	593	639
1981	4,636	1,808	1,576	603	649
1982	4,733	1,846	1,609	615	663
1983	4,777	1,863	1,624	621	669
1984	4,892	1,908	1,663	636	685
1985	5,007	1,952	1,702	651	701
1986	5,089	1,984	1,730	662	722
1987	5,164	2,014	1,756	671	723
1988	5,223	2,037	1,776	679	731
1989	5,276	2,058	1,794	686	739
1990	5,308	2,070	1,805	690	743
1995	5,520	2,153	1,877	718	773
2000	5,871	2,290	1,996	763	822

Source: Five-County 1980
[1]Census data

TABLE K-4

WASHINGTON COUNTY - DISAGGREGATION OF BASELINE POPULATION PROJECTIONS TO AFFECTED COMMUNITIES

	Washington County	Hurricane
1970[1]	13,669	1,408
1980	21,695	1,875
1981	22,640	1,958
1982	23,440	2,028
1983	24,344	2,106
1984	25,355	2,193
1985	26,335	2,278
1986	27,163	2,350
1987	27,976	2,420
1988	28,793	2,490
1989	29,530	2,554
1990	30,669	2,653
1995	33,581	2,905
2000	37,524	3,246

Source: Five-County 1980
[1]Census data

TABLE K-5

DISAGGREGATIONS TO COMMUNITIES: BASELINE PLUS IMPACTS FOR LOW LEVEL OF COAL PRODUCTION PLUS TRUCK TRANSPORTATION

	Garfield County Total	Antimony	Boulder	Cannonville	Escalante	Hatch	Henrieville	Panguitch	Ticaboo	Tropic	County Area
1990[1]	7,125	114	132	133	930	150	254	2,520	2,000	499	386
1991	9,503	160	180	395	1,700	245	520	2,746	2,000	1,050	507
1995	9,503	150	180	363	1,398	230	501	2,900	2,000	998	504
2000	9,904	151	195	404	1,492	242	562	3,219	2,000	1,100	539

	Kane County Total	Alton	Glendale	Kanab	Mt. Carmel	Orderville	West Kane County Area	Glen Canyon City and Area	Page Arizona
1984	5,856	64	233	3,988	113	460	639	359	358
1985	8,758	153	450	5,700	225	719	900	611	1,832
1986	9,363	151	467	6,086	236	742	941	740	2,216
1987	9,763	158	480	6,361	246	762	980	776	2,329
1988	10,199	161	500	6,651	258	783	1,022	824	2,472
1989	10,656	169	522	6,948	270	806	1,065	876	2,630
1990	11,220	180	554	7,286	287	842	1,114	957	2,870
1995	11,344	160	536	7,589	279	807	1,157	807	2,420
2000	13,021	174	606	8,791	320	882	1,331	917	2,751

Source: Five-County 1980

[1]1991 is the first year of significant impact in the low level of production.

[2]Includes impacts only

TABLE K-6

DISAGGREGATIONS TO COMMUNITIES: BASELINE PLUS IMPACTS FOR MEDIUM LEVEL OF COAL PRODUCTION PLUS WORST-CASE TRANSPORTATION CONSTRUCTION IMPACTS

	Garfield County Total	Antimony	Boulder	Cannonville	Escalante	Hatch	Henrieville	Panguitch	Ticaboo	Tropic	County Area
1984	8,170	117	121	122	2,499	148	206	2,153	1,800	434	571
1985	8,665	117	123	124	2,855	148	212	2,279	2,000	444	363
1986	8,470	116	125	125	2,601	147	220	2,317	2,000	454	366
1987	9,232	167	178	405	1,529	249	506	2,656	2,000	1,056	496
1988	11,482	210	224	649	2,241	338	755	2,889	2,000	1,563	611
1989	13,697	252	268	884	2,925	422	995	3,172	2,000	2,058	721
1990	16,030	296	314	1,133	3,649	514	1,254	3,430	2,000	2,590	840
1995	27,830	522	552	2,410	7,352	974	2,548	4,760	2,000	5,276	1,433
2000	25,250	458	503	2,093	6,402	855	2,250	4,753	2,000	4,630	1,308

	Kane County Total	Alton	Glendale	Kanab	Mt. Carmel	Orderville	Rural West Kane County Area	Glen Canyon City and Area	New Town East Kane County	Fredonia[1] Arizona	Page Arizona
1981	11,713	924	209	7,032	95	422	1,073	1,958*		174	326
1982	19,907	1,044	243	8,065	114	467	1,194	2,583	6,197	195	1,110
1983	25,324	1,086	247	8,702	118	474	1,244	1,753	11,700	204	1,748
1984	30,238	1,174	377	7,018	185	630	1,428	2,136	17,290	211	2,457
1985	39,843	160	490	7,046	245	767	945	1,776	28,414		3,552
1986	44,052	176	526	7,579	265	812	1,006	1,981	31,707		3,963
1987	51,564	205	593	8,409	302	893	1,102	2,356	37,704		4,713
1988	44,929	185	560	8,072	289	854	1,088	1,993	31,888		3,986
1989	44,307	186	562	8,187	290	853	1,109	1,948	31,172		3,896
1990	45,565	186	567	8,333	293	857	1,128	1,953	31,248		3,906
1995	46,218	189	606	9,069	314	888	1,233	1,995	31,924		3,990
2000	46,048	182	625	9,880	330	905	1,352	1,927	30,847		3,856

	Beaver County	Beaver City	Milford	Minersville	Rural County Area	Washington County	Hurricane	Rural[1] Washington County Area	Iron[1] County Area	Piute[1] County Area	Greenwich/ Koosharem
1981	5,682	2,157	1,925	777	823	25,189	4,263	244	139		
1982	5,905	2,237	2,000	810	858	26,148	4,462	274	156		
1983	6,425	2,272	2,455	825	873	27,064	4,540	286	163		
1984	6,158	2,330	2,085	847	896	76,707	3,249	296	169		902
1985	5,007	1,952	1,702	651	701	26,335	2,278			361	1,076
1986	5,089	1,984	1,730	662	722	27,163	2,350			399	945
1987	5,164	2,014	1,756	671	723	27,976	2,420				
1988	5,223	2,037	1,776	679	731	28,793	2,490				
1989	5,276	2,058	1,794	686	739	29,530	2,554				
1990	5,308	2,070	1,805	690	743	30,669	2,653				
1995	5,520	2,153	1,877	718	773	33,581	2,905				
2000	5,871	2,290	1,996	763	822	37,524	3,246				

Source: Five-County 1980

[1]Includes impacts only, no baseline provided.

TABLE K-7

DISAGGREGATIONS TO COMMUNITIES: BASELINE PLUS IMPACTS OF HIGH LEVEL OF COAL PRODUCTION PLUS WORST-CASE TRANSPORTATION CONSTRUCTION IMPACTS

	Garfield County Total	Antimony	Boulder	Cannonville	Escalante	Hatch	Henrieville	Panguitch	Ticaboo	Tropic	Rural County Area
1985	9,762	1,453	123	124	2,039	148	212	2,279	2,000	444	941
1986	10,175	1,594	125	125	2,189	147	220	2,317	2,000	454	1,005
1987	11,685	216	226	675	2,313	347	775	2,901	2,000	1,610	618
1988	15,707	294	308	1,113	3,594	507	1,219	3,312	2,000	2,535	822
1989	19,905	375	392	1,566	4,911	670	1,678	3,793	2,000	3,486	1,032
1990	24,310	461	479	2,043	6,307	844	2,164	4,260	2,000	4,493	1,254
1995	47,483	915	945	4,572	13,642	1,760	4,710	6,725	2,000	9,798	2,416
2000	42,370	800	845	3,975	11,881	1,540	4,133	6,466	2,000	8,568	2,162

	Kane County Total	Alton	Glendale	Kanab	Mt. Carmel	Orderville	Rural West Kane County Area	Glen Canyon City and Area	New Town East Kane County	Fredonia[1] Arizona	Page[1] Arizona
1981	11,713	924	209	7,032	95	422	1,073	1,958*		174	326
1982	23,237	1,044	243	8,065	114	467	1,194	2,779	9,331	195	1,532
1983	31,516	1,086	247	8,702	118	474	1,244	2,117	17,528	204	2,476
1984	38,810	1,174	377	7,018	185	630	1,428	2,640	25,358	211	3,466
1985	48,258	160	490	7,342	245	767	945	2,253	36,056		4,507
1986	59,178	176	526	8,368	265	812	1,006	2,825	45,200		5,650
1987	70,950	205	593	9,443	302	893	1,102	3,436	54,976		6,872
1988	59,653	185	560	8,825	289	854	1,088	2,815	45,036		5,630
1989	58,966	186	562	8,914	290	853	1,109	2,768	44,284		5,535
1990	59,421	186	567	9,088	293	857	1,128	2,782	44,520		5,565
1995	62,268	189	606	9,913	314	888	1,233	2,890	46,235		5,779
2000	62,031	182	625	10,760	330	905	1,352	2,832	45,315		5,664

	Beaver County	Beaver City	Milford	Minersville	Rural County Area	Washington County	Hurricane	Rural[1] Washington County Area	Iron[1] County Area	Piute[1] County Area
1981	5,682	2,157	1,925	777	823	25,516	4,590	244	139	
1982	5,905	2,237	2,000	810	858	26,301	4,615	274	156	
1983	6,425	2,272	2,455	825	873	27,222	4,698	286	163	
1984	6,158	2,330	2,085	847	896	26,707	3,249	296	169	
1985	5,007	1,952	1,702	651	701	26,335	2,278			361
1986	5,089	1,984	1,730	662	722	27,163	2,350			399
1987	5,164	2,014	1,756	671	723	27,976	2,420			
1988	5,223	2,037	1,776	679	731	28,793	2,490			
1989	5,276	2,058	1,794	686	739	29,530	2,554			
1990	5,308	2,070	1,805	690	743	30,669	2,653			
1995	5,520	2,153	1,877	718	773	33,581	2,905			
2000	5,871	2,290	1,996	763	822	37,524	3,246			

Source: Five-County 1980

[1]Includes impacts only, no baseline provided.

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